User's Manual

LG Programmable Logic Controller

MASTER-K K7F – PIDA K4F – PIDA

LG **Industrial Systems**

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SAFETY PRECAUTIONS

Be sure to read carefully the safety precautions given in data sheet and user's manual before operating the module and follow them.

The precautions explained here only apply to the K7F-PIDA and K4F-PIDA.

For safety precautions on the PLC system, see the MASTER-K200S/300S/1000S User's Manuals.

A precaution is given with a hazard alert triangular symbol to call your attention, and precautions are represented as follows according to the degree of hazard.

⚠ WARNING ⇨ If not provided with proper prevention, it can cause death or fatal injury or considerable loss of property.

⚠ CAUTION ⇨ If not properly observed, it can cause a hazard situation to result in severe or slight injury or a loss of property.

However, a precaution followed with ⚠ **CAUTION** can also result in serious conditions.

Both of two symbols indicate that an important content is mentioned, therefore, be sure to observe it.

Keep this manual handy for your quick reference in necessary.

Installation Precautions

⚠ CAUTION

- Operate the PLC in the environment conditions given in the general specifications.
- If operated in other environment not specified in the general specifications, it can cause an electric shock, a fire, malfunction or damage or degradation of the module
- Make sure the module fixing projections is inserted into the module fixing hole and fixed.
- Improper installation of the module can cause malfunction, disorder or falling.

Test Run and Maintenance Precautions

⚠ CAUTION

- Do not separate the module from the printed circuit board(PCB), or do not remodel the module.
  They can cause disorder, malfunction, damage of the module or a fire.
  When mounting or dismounting the module, perform them after the power has been turned off.
- Do not perform works while the power is applied, which can cause disorder or malfunction.

Waste Disposal Precautions

⚠ CAUTION

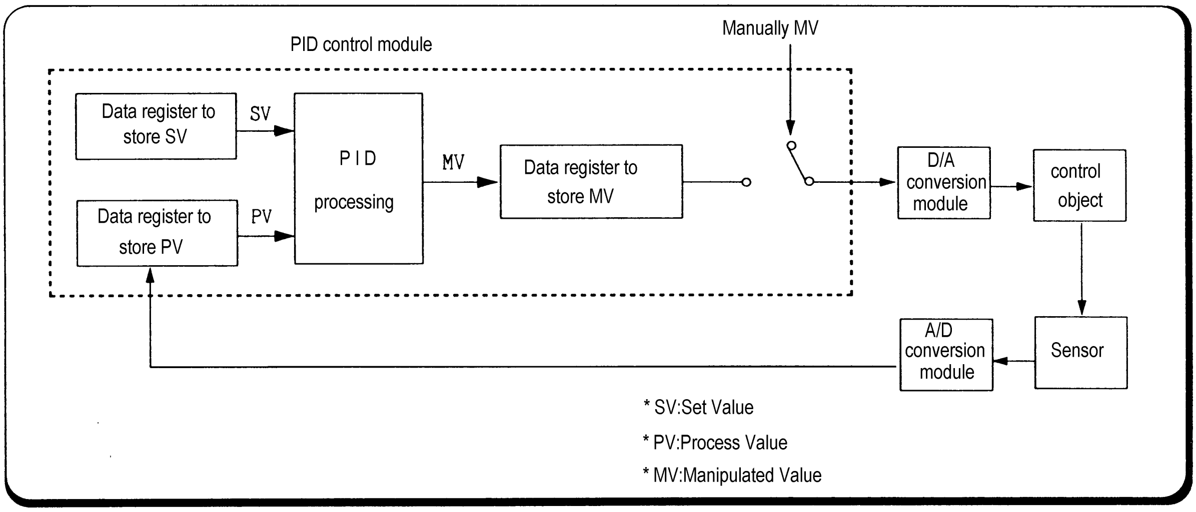
- When disposing the module, do it as an industrial waste.

Chapter 1.   INTRODUCTION

These two modules are called K7F-PIDA and K4F-PIDA. The K7F-PIDA is used with the CPU of K1000S series, and the K4F-PIDA is used with the CPU of K300S series. Hereafter, the two modules will be commonly called the PID control module.

PID control means a control action that in order to keep the object at a value set beforehand (SV), it compares the SV with a sensor-measured value (PV) and when a difference between them is detected the controller makes PV come to be SV by adjusting output to eliminate the difference. The PID control is composed of combinations of Proportional (P), Integral (I) and Derivative (D) actions.

When a difference between SV and PV occurs, proportional, integral, differential quantities are calculated upon that difference and a MV(Manipulated Value) is output.



1.1   Features

The features of the PID control module are as follows.

1) One module can control various processes separately and at the same time.
2) Forward/reverse action selection is available.
3) Manually manipulated out (forced to be output by the user), not operation processing output, is available.
4) The number of modules available on one base unit is unlimited.

Chapter 2 . SPECIFICATIONS

2.1 General Specifications

Table 2.1 shows the general specifications of MASTER-K series.

<table>
<tr><th>No</th><th>Items</th><th colspan="4">Specifications</th><th>Standard</th></tr>
<tr><td>1</td><td>Operating ambient temperature</td><td colspan="4">0 ~ 55℃</td><td></td></tr>
<tr><td>2</td><td>Storage ambient temperature</td><td colspan="4">-25 ~ 70℃</td><td></td></tr>
<tr><td>3</td><td>Operating ambient humidity</td><td colspan="4">5 ~ 95%RH, non-condensing</td><td></td></tr>
<tr><td>4</td><td>Storage ambient humidity</td><td colspan="4">5 ~ 95%RH, non-condensing</td><td></td></tr>
<tr><td rowspan="9">5</td><td rowspan="9">Vibration</td><td colspan="4">Occasional vibration</td><td rowspan="9">IEC 1131-2</td></tr>
<tr><td>Frequency</td><td>Acceleration</td><td>Amplitude</td><td>Sweep count</td></tr>
<tr><td>10≤f∠57 Hz</td><td>-</td><td>0.075 mm</td><td rowspan="7">10 times in each direction for X, Y, Z</td></tr>
<tr><td>57 ≤f≤150 Hz</td><td>9.8㎨ {1G}</td><td>-</td></tr>
<tr><td colspan="3">Continuous vibration</td></tr>
<tr><td>Frequency</td><td>Acceleration</td><td>Amplitude</td></tr>
<tr><td>10≤f∠57 Hz</td><td>-</td><td>0.035 mm</td></tr>
<tr><td>57≤f≤150 Hz</td><td>4.9㎨ {0.5G}</td><td>-</td></tr>
<tr></tr>
<tr><td>6</td><td>Shocks</td><td colspan="4">*Maximum shock acceleration: 147 ㎨ {15G}
*Duration time :11 ms
*Pulse wave: half sine wave pulse(3 times in each of X, Y and Z directions)</td><td>IEC 1131-2</td></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Noise immunity</td><td>Square wave impulse noise</td><td colspan="3">±1,500 V</td><td></td></tr>
<tr><td>Electrostatic discharge</td><td colspan="3">Voltage :4kV(contact discharge)</td><td>IEC 1131-2
IEC 801-2</td></tr>
<tr><td>Radiated electromagnetic field</td><td colspan="3">27 ~ 500 MHz, 10 V/m</td><td>IEC 1131-2
IEC 801-3</td></tr>
<tr><td rowspan="2">Fast transient burst noise</td><td>Severity Level
Voltage</td><td>All power modules
2 kV</td><td>Digital I/Os (Ue ≥ 24 V)
1 kV</td><td>Digital I/Os (Ue < 24 V) Analog I/Os communication I/Os
0.25 kV</td><td rowspan="2">IEC 1131-2
IEC 801-4</td></tr>
<tr></tr>
<tr><td>8</td><td>Operating atmosphere</td><td colspan="4">Free from corrosive gases and excessive dust</td><td></td></tr>
<tr><td>9</td><td>Altitude for use</td><td colspan="4">Up to 2,000m</td><td></td></tr>
<tr><td>10</td><td>Pollution degree</td><td colspan="4">2 or lower</td><td></td></tr>
<tr><td>11</td><td>Cooling method</td><td colspan="4">Self-cooling</td><td></td></tr>
</table>

[Table 2.1] General specifications

REMARK

1) IEC(International Electrotechnical Commission)

: The international civilian organization which produces standards for electrical and electronics industry.

2) Pollution degree

: It indicates a standard of operating ambient pollution level.

The pollution degree 2 means the condition in which normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

2.2 Performance Specifications

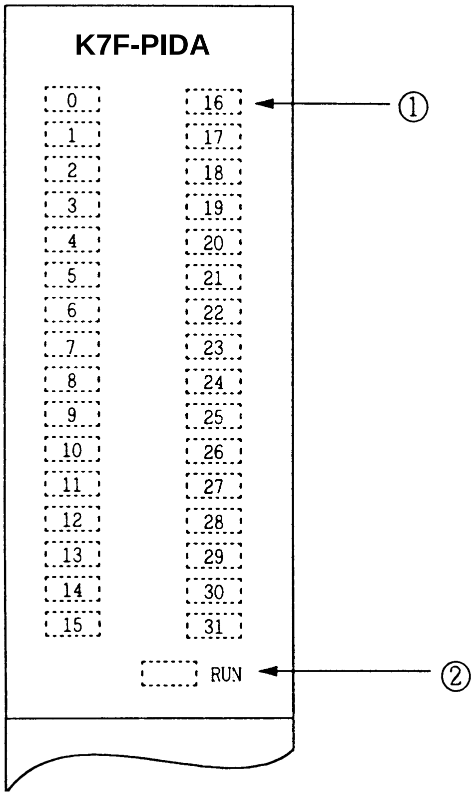
Table. 2.2 shows performance specifications of the PID control module.

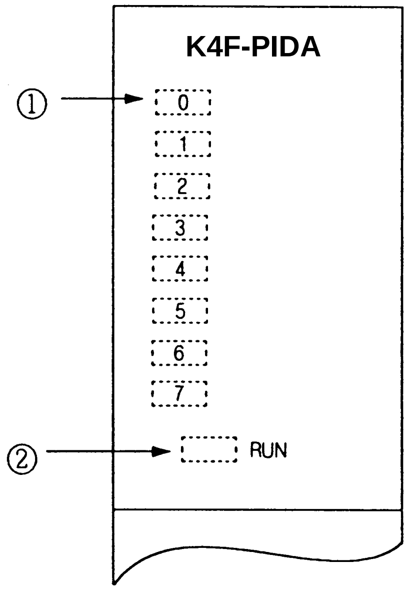
<table>
<tr><th colspan="2" rowspan="2">Items</th><th colspan="2">Specifications</th></tr>
<tr><th>K7F-PIDA</th><th>K4F-PIDA</th></tr>
<tr><td rowspan="3">Setting range of PID constants</td><td>Proportional constant (P)</td><td colspan="2">0.01 ~ 100.00
(When integral and derivative constants are set to 0.0 sec, proportional action is applied.)</td></tr>
<tr><td>Integral constant (I)</td><td colspan="2">0.0 ~ 3000.0 sec
(When integral constant is set to 0.0 sec, integral action shall not be applied.)</td></tr>
<tr><td>Derivative constant (D)</td><td colspan="2">0.0 ~ 3000.0 sec
(When derivative constant is set to 0.0 sec, derivative action shall not be applied.)</td></tr>
<tr><td colspan="2">Setting range : SV (Set Value)</td><td colspan="2">0 ~ 16,000</td></tr>
<tr><td colspan="2">Input range : PV (Process Value)</td><td colspan="2">0 ~ 16,000</td></tr>
<tr><td colspan="2">Output range : MV (Manipulated Value)</td><td colspan="2">0 ~ 16,000</td></tr>
<tr><td colspan="2">Setting range : M_MV
(Manually Manipulated Value)</td><td colspan="2">0 ~ 16,000</td></tr>
<tr><td rowspan="2">LED</td><td>RUN / STOP</td><td colspan="2">RUN : The run LED of corresponding loops ON
STOP : The run LED of corresponding loops OFF</td></tr>
<tr><td>NORMAL/ERROR</td><td colspan="2">Normal : RUN LED ON
Error : RUN LED flickering</td></tr>
<tr><td colspan="2">Number of PID control loops</td><td>32 loops</td><td>8 loops</td></tr>
<tr><td colspan="2">Control action</td><td colspan="2">Forward/Reverse action control is available.</td></tr>
<tr><td colspan="2">Control cycle</td><td colspan="2">0.1 sec</td></tr>
<tr><td colspan="2">Processing type</td><td colspan="2">Measured value derivative type
(Pre-derivative type)</td></tr>
<tr><td colspan="2">Internal current consumption</td><td>0.3 A</td><td>0.2 A</td></tr>
<tr><td colspan="2">Weight</td><td>370 g</td><td>190 g</td></tr>
</table>

[Table. 2.2 Performance Specifications]

2.3 Names of Parts and Functions

The following gives names of parts :





No.	Descriptions
①	Loop Run LED It shows the PID control module run status. ● ON : The corresponding loop is running. ● OFF : The corresponding loop is running. ● Flickering : Error status. Error Value is displayed.
②	RUN LED It shows the PID module Operating status. ● ON: Normal ● Flickering : Error

2.4 PID Control Action

2.4.1 Processing type

1) Velocity type

Velocity type is a processing that in PID processing, the present Manipulated Value(MV) is obtained by adding the calculated variation of MV (ΔMV) to the previous MV

$$MV_n = MV_{n-1} + \Delta MV_n$$

MV_n : Present Manipulated Value

MV_{n-1} : Previous Manipulated Value

ΔMV_n : Variation of the Previous Manipulated Value

2) Measured Value Derivative Type (Pre-derivative)

Measured value derivative processing, in PID processing, uses the process value(PV) for the derivative term. Generally, PID processing, when a deviation occurs, operates toward the direction in which the deviation will be reduced.
The deviation occurs due to alteration of set value(SV) or outside disturbances. Therefore, if the deviation is used in the derivative processing, the output of the derivative term changes rapidly when the deviation occur due to alteration of set value (SV). So, to prevent raid changes like that, this processing uses the process value(PV) for the derivative term.

$$MV_n = MV_{n-1} + K_p \times (E_n - E_{n-1}) + K_p \times S/K_i \times E_n$$
$$+ K_p \times K_d/S \times (2PV_n - PV_{n-1} - PV_{n-2})$$

MV_n : Present Manipulated Value

MV_{n-1} : Previous Manipulated Value

ΔMV_n : Variation of the Previous Manipulated Value

E_n : Present Deviation

E_{n-1} : Previous Deviation

K_p : Proportional Constant

K_i : Integral Constant

K_d : Derivative Constant

S : Control Cycle (100ms)

PV_n : Present Process Quantity (Present Value)

PV_{n-1} : One-step previous Process Quantity (Present Value)

PV_{n-2} : Two-step previous Process Quantity (Present Value)

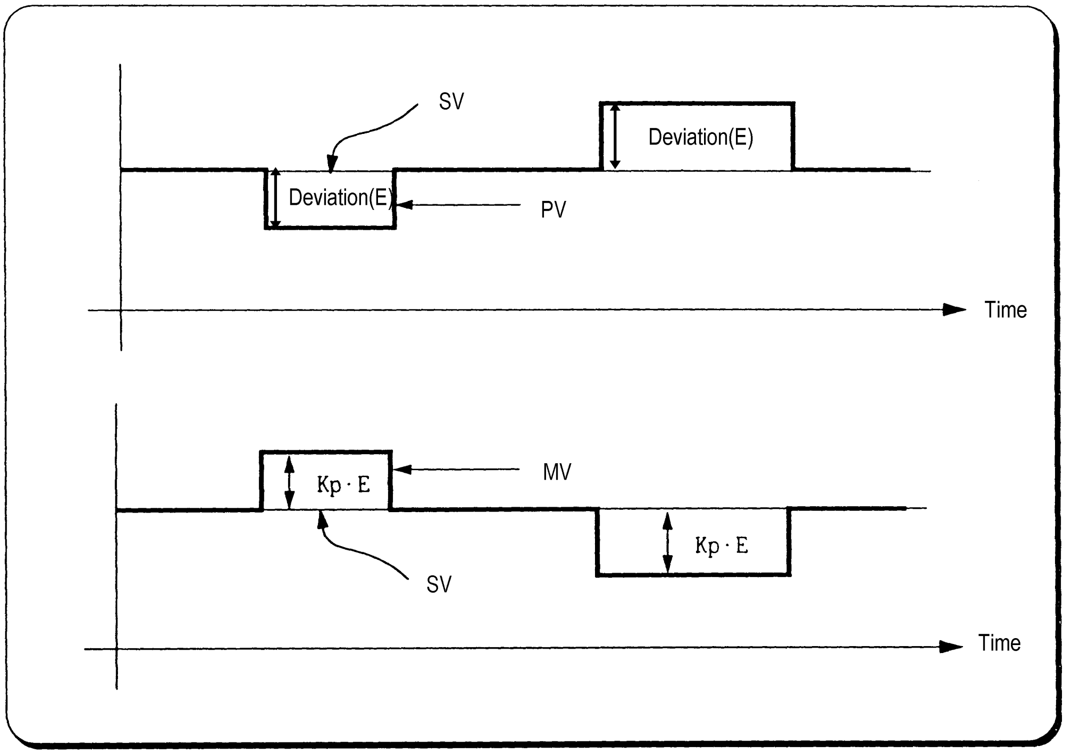
2.4.2 Control Action

1) Proportional Action (P Action)

(1) P action means a control action that obtains a MV which is proportional to the deviation (E: the difference between SV and PV).
(2) The expression which denotes the change relationship of E to MV in P action is shown as follows:

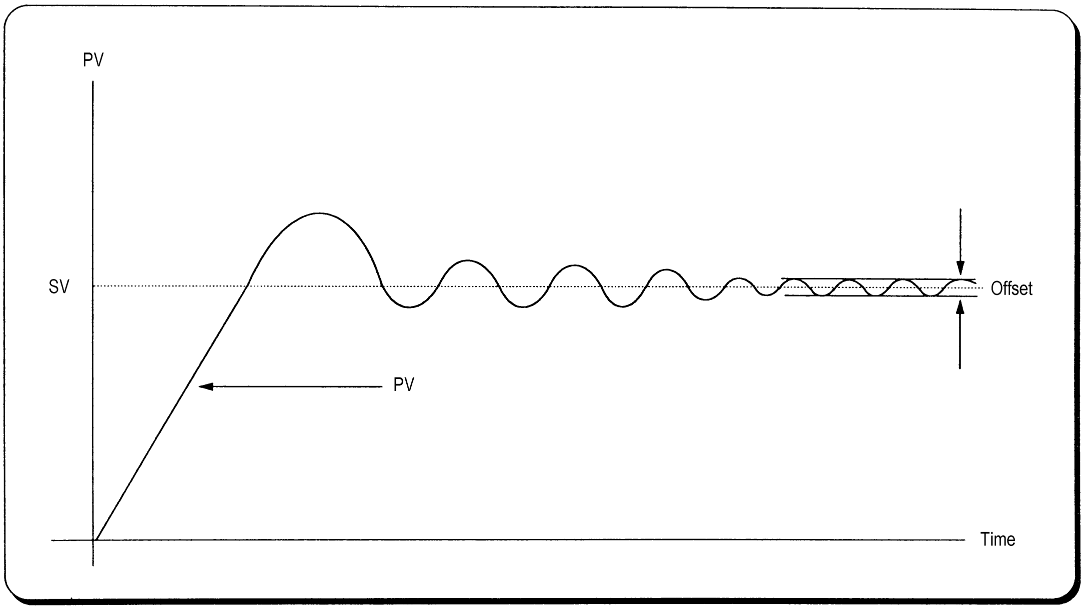
$$MV = Kp \times E$$

where Kp is a proportional constant and means gain.
(3) When deviation occurs, the MV by P action is shown in Fig. 2.1.

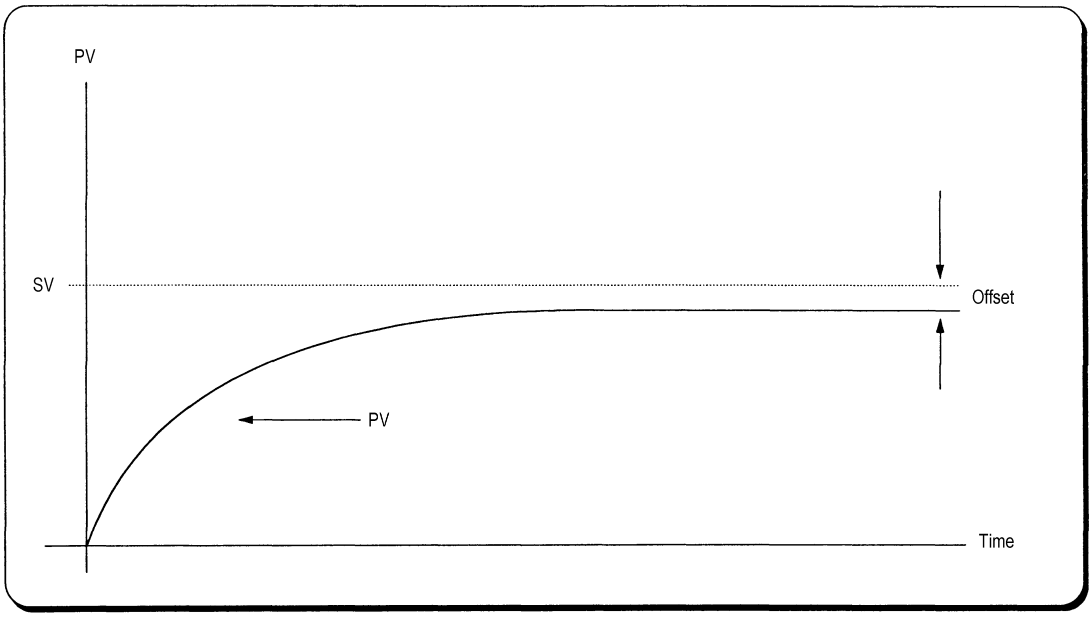


[Fig. 2.1]   MV with the proportional action

(4) As shown in Fig. 2.1, the larger the proportional constant Kp the larger the MV, that is, the stronger the P action when the deviation(E) is same . Also, the smaller the Kp the smaller the MV after P action.
(5) If the Kp is too large, PV reaches SV swiftly but can make bad effects like oscillations shown in Fig. 2.2 and cause damage in control stability.
(6) If the Kp is too small, oscillations do not occur but the velocity with which PV reaches SV slows down and offset can happen as shown in Fig. 2.3.
(7) Manipulated Value varies within 0 to 16,000.



[Fig. 2.2] When the proportional constant Kp is large.

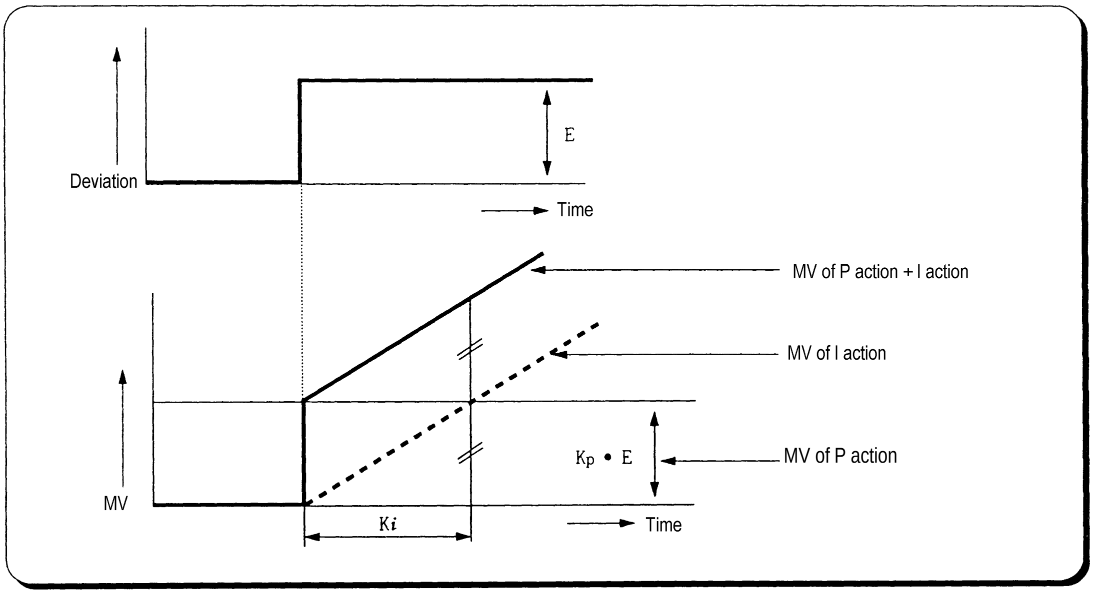


[Fig. 2.3] When the proportional constant Kp is small.

2) Integral Action (I Aaction)

(1) When a deviation(E) occurs between SV and PV, Integral action continuously adds the deviation to or subtracts it from the MV in accordance time in order to eliminate the deviation
When a deviation is small it is not expected that the MV will be changed by P action but I action will eliminate it.
Therefore, the offset which occurs in P action can be eliminated by I action.
(2) The period of the time from when the deviation has occurred in I action to when the MV of I action become that of P action is called Integration time and represented as Ki.
(3) Integral action when a given deviation has occurred is shown as the following Fig. 2.4.

MV

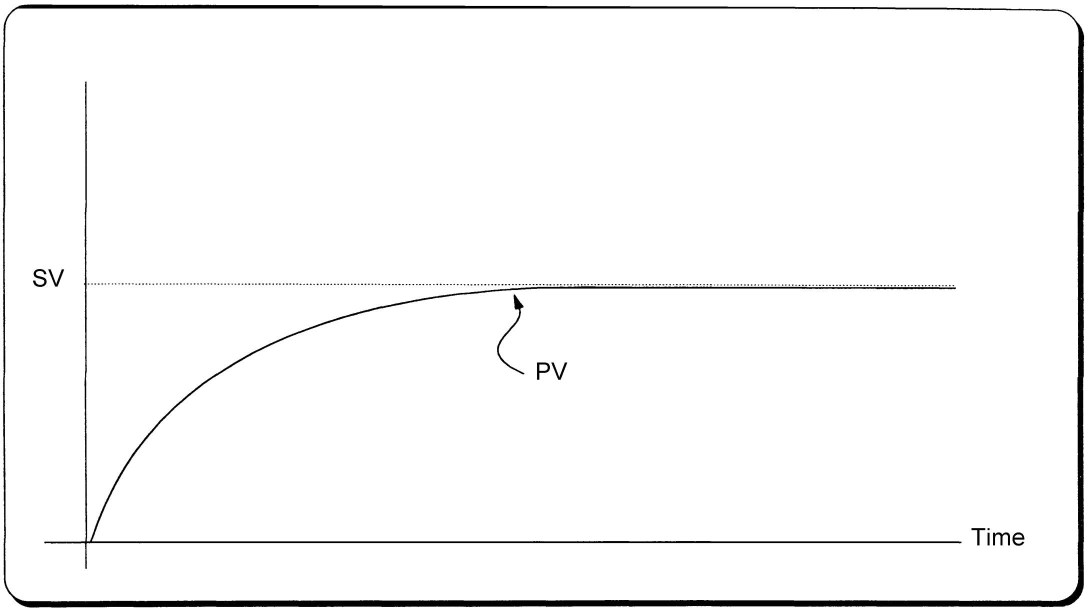


[Fig. 2.4]   Integral action at a constant deviation

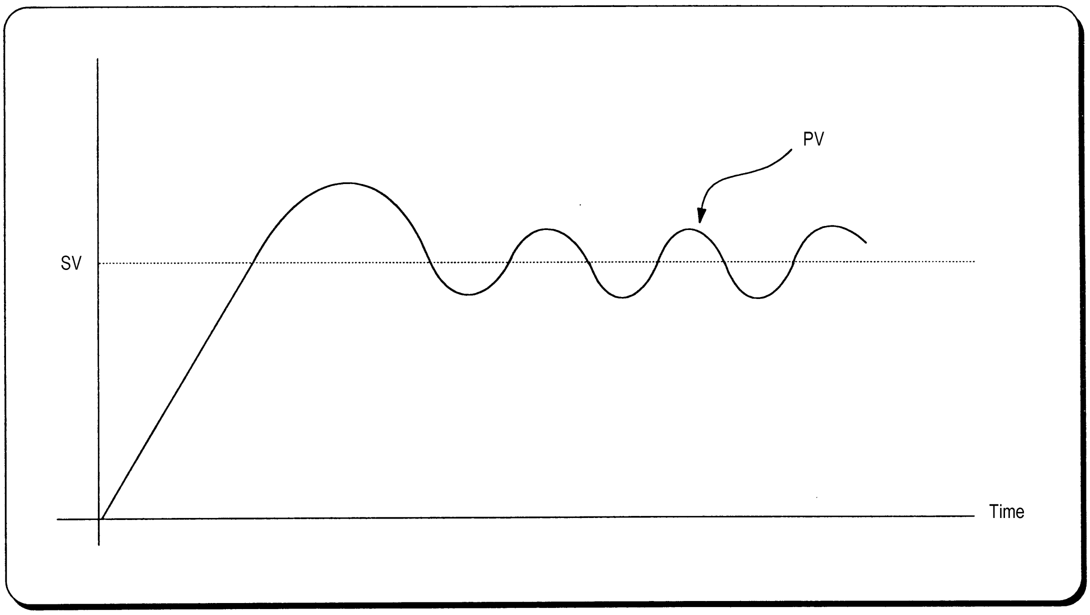
(4) Expression of Integral Action is as follows:

$$MV = P \times E + P \times \frac{1}{K_i} \times \int E dt$$

As shown in the expression, Integral action can be made stronger or weaker by adjusting integration time (K*i*) in I action.
That is, the more the integration time (the longer the integration time) as shown in Fig. 2.5, the lesser the quantity added to or subtracted from the MV and the longer the time needed for the PV to reach the SV.
As shown in Fig. 2.6, when the integration time given is short the PV will approach the SV in short time since the quantity added or subtracted become increased. But, If the integration time is too short   then oscillations occurs, therefore, the proper P.I value is requested.
(5) Integral action is used in either PI action in which P action combines with I action or PID action in which P and D actions combine with I action.



[Fig. 2.5] When a long integration time is given.



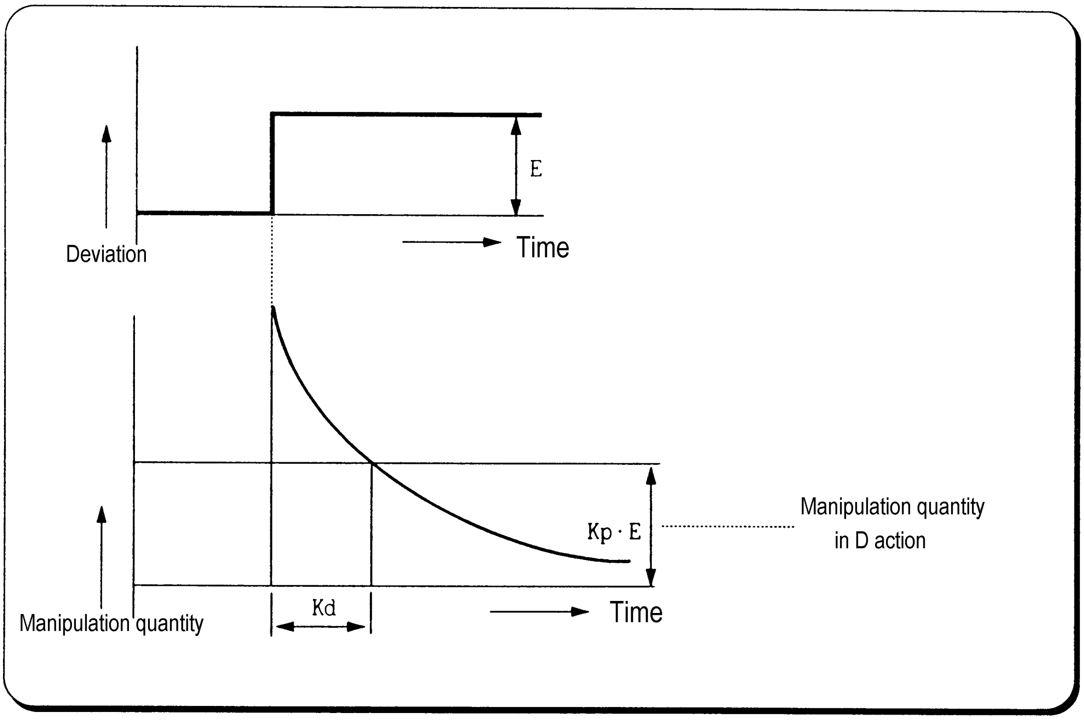
[Fig. 2.5] When a short integration time is given.

3) Derivative Action (D Action)

(1) When a deviation occurs due to alteration of SV or external disturbances, D action restrains the changes of the deviation by producing MV which is proportioned with the change velocity (a velocity whose deviation changes at every constant interval) in order to eliminate the deviation.
- D action gives quick response to control action and has an effect to reduce swiftly the deviation by applying a large control action (in the direction that the deviation will be eliminated) at the earlier time that the deviation occurs.
- D action can prevent the large changes of control object due to external conditions.

(2) The period of time from when the deviation has occurred to when the MV of D action become the MV of P action is called derivative time and represented as Kd.

(3) The D action when a given deviation occurred is shown as Fig. 2.7.



[Fig. 2.7] Derivative action at a constant deviation

(4) The expression of D action is represented as follows:

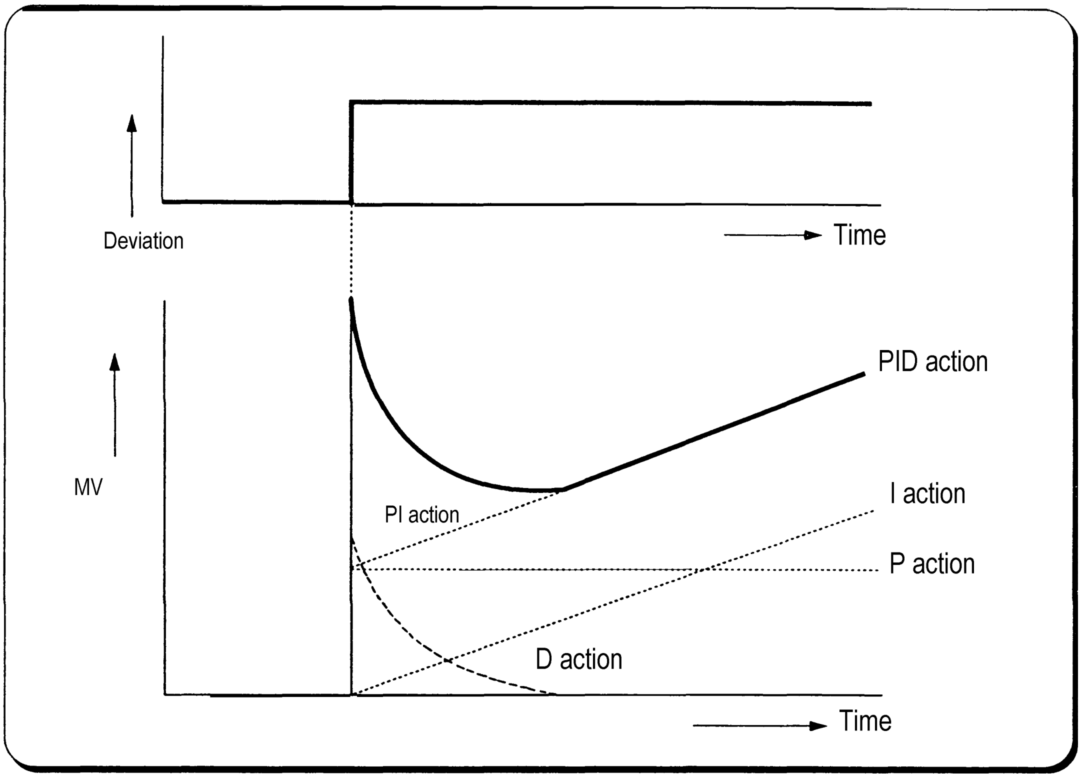
$$MV = K_p \times E + K_p \times \frac{dE}{dt}$$

- In this expression, an output proportional with the variation rate of deviation is added to P action quantity.
- If the derivative time is increased then P action is strengthened.
- D action is applied when a change of deviation occurs and the deviation at normal state become 0. D action, therefore, do not reduce offset.

(5) D action is used in either PD action in which P action combines with D action or PID action in which P and I actions combine with D action.

4) PID Action

(1) PID action controls the control object with the manipulation quantity produced by (P+I+D) action.
(2) PID action when a given deviation has occurred is shown as the following Fig. 2.8.



[Fig. 2.8] PID action at a constant deviation

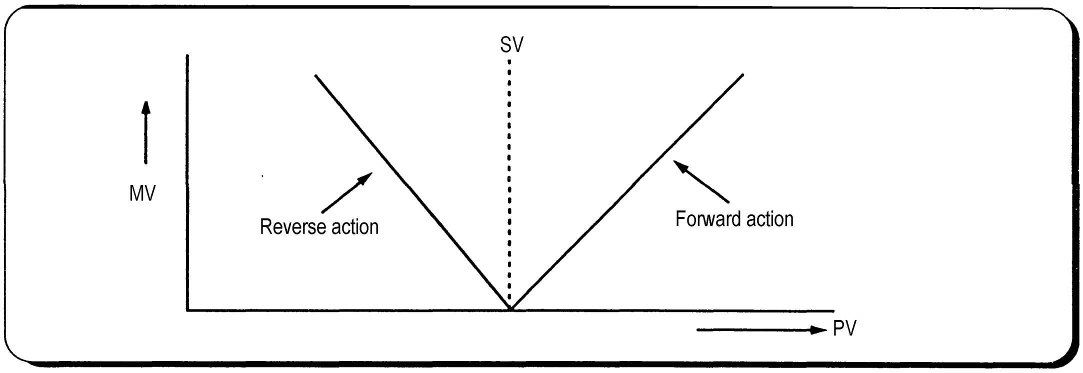
5) PID Processing Expression

PID expressions are of measured value derivative type.

Expressions	Parameters names
$E_n = SV - PV_n$ $MV_n = MV_{n-1} + K_p \times (E_n - E_{n-1})$ $+ K_p \times S/K_I \times E_n$ $+ K_p \times K_d/S \times (2PV_n - PV_{n-1} - PV_{n-2})$	**MVn** : Present Manipulated Value **MVn-1** : One-step-previous Manipulated Value **En** : Present deviation **En-1** : Previous deviation **Kp** : Proportional constant **Ki** : Integral constant **Kd** : Derivative constant **S** : Control cycle (100 ms) **PVn** : Process value **PVn-1** : One-step-previous Process Value **PVn-2** : Two-step-previous Process value

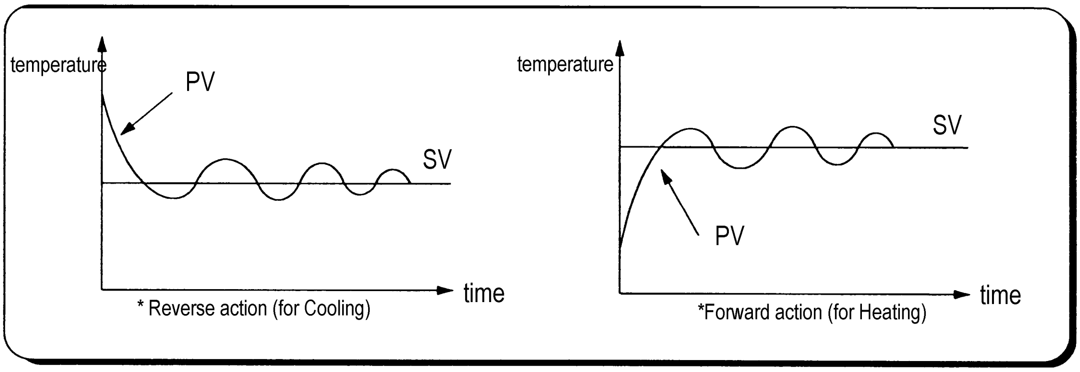
6) Forward/Reverse Actions

(1) PID control has two kinds of action, forward action and reverse action.
  a) Forward action makes PV reach SV by outputting MV when PV is less than SV.
  b) Reverse action makes PV reach SV by outputting MV when PV is more than SV.
(2) A diagram in which forward and reverse actions are drawn using MV, PV and SV is shown as Fig. 2.9.



[Fig. 2.9] Forward and reverse action with MV, PV and SV

(3) Fig 2.10 shows examples of process control by forward and reverse actions, respectively.



[Fig. 2.9] Examples of process control by forward and reverse actions

Chapter 3. INSTALLATION

3.1 Installation Ambience

This module has high reliability regardless of its installation ambience. But be sure to check the following for system in higher reliability and stability.

1) Ambience Requirements

Avoid installing this module in locations, which are subjected or exposed to:

- Water leakage and dust a large amount of dust, powder and other conductive power, oil mist, salt, of organic solvent exists.
- Mechanical vibrations of impacts are transmitted directly to the module body.
- Direct sunlight.
- Dew condensation due to sudden temperature change.
- High or low temperatures (outside the range of 0-55℃)

2) Installing and Wiring

- During wiring or other work, do not allow any wire scraps to enter into the PLC
- Install it on locations that are convenient for operation.
- Make sure that it is not located near high voltage equipment on the same panel.
- Make sure that the distance from the walls of duct and external equipment be 50 mm or more.
- Be sure to be grounded to locations that have good noise immunity.

3.2 Handling Precautions

From unpacking to installing the PID control module, be sure to check the following:

1) Do not drop it off, and make sure that strong impacts should not be applied.
2) Do not dismount printed circuit boards from the case. It can cause malfunctions.
3) During wiring, be sure to check any foreign matter like wire scraps should not enter into the upper side of the PLC, and in the event that foreign matter entered into it, always eliminate it.
4) Be sure to disconnect electrical power before mounting or dismounting the module.

Chapter 4. BUFFER MEMORY CONFIGURATION AND FUNCTIONS

The PID control module has the PLC CPU and the buffer memories for communications.

4.1 Buffer memory Configuration

The followings describe buffer memory configuration.

4.1.1 K7F-PIDA Buffer Memory

Address (Decimal)	Function	Descriptions	Default Setting	Read / Write
0	Loop enable/disable Specification area (loop 0 to 15)	Bit On(1): Enabled Bit Off(0): Disabled	Disabled	R/W
1	Loop enable/disable Specification area (loop 16 to 31)			
2	Auto/Manual operation Specification area (loop 0 to 15)	Bit On(1): Auto Bit Off(0): Manual	Auto	R/W
3	Auto/Manual operation Specification area (loop 16 to 31))			
4	Forward/Reverse action Specification area (loop 0 to 15)	Bit On(1): Reverse Bit Off(0): Forward	Forward	R/W
5	Forward/Reverse action Specification area (loop 16 to 31)			
6	Set data enable/disable Specification area (loop 0 to 15)	Bit On(1) : Set each content of address 0, 1, 4, 5, 10 to 41, and 74 to 201 to a new setting. Bit Off(0) : The previous values of address 0, 1, 4, 5, 10 to 41, and 74 to 201 remains without change.	No Setting Values	R/W
7	Set data enable/disable Specification area (loop 16 to 31)			
8	Loop run information (loop 0 to 15)	Bit On(1) : Run Bit Off(0) : Stop	—	Read Only
9	Loop run information (loop 16 to 31)			
10 to 41	SV of each loop	Setting range : 0 to 16000	"0"	R/W
42 to 73	PV of each loop	Input range : 0 to 16000	"0"	R/W
74 to 105	M-MV of each loop	Setting range : 0 to 16000	"0"	R/W
106 to 137	P of each loop	Setting range : 0 to 10000	"500"	R/W
138 to 169	I of each loop	Setting range : 0 to 30000	"1000"	R/W
170 to 201	D of each loop	Setting range : 0 to 30000	"0"	R/W
202 to 233	MV of each loop	Output range : 0 to 16000	—	Read
234 to 265	Error information of each loop	Bit 0 On(1) : out-of-range SV Bit 1 On(1) : out-of-range PV Bit 2 On(1) : out-of-range M_MV Bit 3 On(1) : out-of-range P Bit 4 On(1) : out-of-range I Bit 5 On(1) : out-of-range D	—	Read Only

4.1.2 K4F-PIDA Buffer Memory

Address (Decimal)	Function	Descriptions	Default Setting	Read / Write
0	Loop enable/disable Specification area	Bit On(1): Enabled Bit Off(0): Disabled	Disabled	R/W
1	Auto/Manual operation Specification area	Bit On(1): Auto Bit Off(0): Manual	Auto	R/W
2	Forward/Reverse action Specification area	Bit On(1): Reverse Bit Off(0): Forward	Forward	R/W
3	SET data enable/disable Specification area	Bit On(1) : Set each content of address 0, 2, 5 to 12, and 21 to 52 to a new setting. Bit Off(0) : The previous values of address 0, 2, 5 to 12, and 21 to 52 remains without change.	No Setting Values	R/W
4	Loop run information	Bit On(1) : Run Bit Off(0) : Stop	—	Read Only
5 to 12	SV of each loop	Setting range : 0 to 16000	"0"	R/W
13 to 20	PV of each loop	Input range : 0 to 16000	"0"	R/W
21 to 28	M_MV of each loop	Setting range : 0 to 16000	"0"	R/W
29 to 36	P of each loop	Setting range : 0 to 10000	"500"	R/W
37 to 44	I of each loop	Setting range : 0 to 30000	"1000"	R/W
45 to 52	D of each loop	Setting range : 0 to 30000	"0"	R/W
53 to 60	MV of each loop	Output range : 0 to 16000	—	Read
61 to 68	Error information of each loop	Bit 0 On(1) : out-of-range SV Bit 1 On(1) : out-of-range PV Bit 2 On(1) : out-of-range M_MV Bit 3 On(1) : out-of-range P Bit 4 On(1) : out-of-range I Bit 5 On(1) : out-of-range D	—	Read Only

4.2 Functions of Buffer Memory

Each address in the buffer memory occupies one word and it is represented with 16 bits.
In the 16 bits which compose an address, every bit can be set to either “1” when it should be turned On or “0” when Off in order to implement the function of each bit.

4.2.1 Specifying Loop Enable/Disable (K7F-PIDA : Addresses 0, 1, K4F-PIDA : Address 0)

1) Loop enable/disable specification is possible on every channel.
2) Disabled loops will not be used in processing.
3) The followings show the bit corresponding to each loop.

(1) K7F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "0" ●	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
Address "1" ●	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

Loop enable/disable specification [Bit On(1): Enabled, Bit Off(0): Disabled]

(2) K4F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "0" ●	—	—	—	—	—	—	—	—	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

Bits 15–8: Ignored

Bits 7–0: Loop enable/disable specification [Bit On(1): Enabled, Bit Off(0): Disabled]

4.2.2 Specifying Auto/Manual Processing (K7F-PIDA : Addresses 2, 3, K4F-PIDA : Address 1)

1) Turn the corresponding bit Off(0) if a loop runs with auto processing. Turn the corresponding bit On if a loop runs with M_MV set before by the user.
2) Default is auto processing.
3) The followings show the bit corresponding to each loop.

(1) K7F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "2" ●	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
Address "3" ●	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

Auto/manual processing specification [Bit On(1): Manual, Bit Off(0): Auto]

(2) K4F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "1" ●	—	—	—	—	—	—	—	—	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

Bits 15–8: Ignored

Bits 7–0: Auto/manual processing specification [Bit On(1): Manual, Bit Off(0): Auto]

4.2.3 Specifying Forward/Reverse Action (K7F-PIDA : Addresses 4, 5, K4F-PIDA : Address 2)

1) Turns the corresponding bit Off(0) for forward action processing and On (1) for reverse action processing.
2) Default is forward action.
3) The following show the bit corresponding to each loop.

(1) K7F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "4"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
Address "5"	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

Forward/reverse action specification [Bit On(1): Reverse, Bit Off(0): Forward]

(2) K4F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "2"	—	—	—	—	—	—	—	—	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

Bit 15 – Bit 8: Ignored

Bit 7 – Bit 0: Forward/reverse action specification [Bit On(1): Forward, Bit Off(0): Reverse]

4.2.4 Specifying SET Data Enable/Disable (K7F-PIDA : Addresses 6, 7, K4F-PIDA : Address 3)

1) If a bit, corresponding to each loop, in Set Data specification area is turned On(1), then the PID processing is executed with new user-defined data due to loop enable/disable specification, forward/reverse action specification, setting SV, setting M_MV, and change of P.I.D constants.
2) If the bit corresponding to each loop is not turned On(1), then the PID processing is executed not with the new user-defined data but with the previous Setting range.
3) The followings show the bit corresponding to each loop.

(1) K7F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "6"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
Address "7"	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

SET data enable/disable specification [Bit On(1):Enabled, Bit Off(0): Disabled]

(2) K4F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "3"	—	—	—	—	—	—	—	—	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

Bit 15 – Bit 8: Ignored

Bit 7 – Bit 0: SET data enable/disable specification [Bit On(1): Enabled, Bit Off(0): Disabled]

8.2.5 Loop Run Information (K7F-PIDA : Addresses 8, 9, K4F-PIDA : Address 4)

1) This area stores information on run status of each loop.

(1) K7F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "8"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "9"	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

Loop Run Information [Bit On(1):Run state, Bit Off(0): Stop state]

(2) K4F-PIDA

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "4"	—	—	—	—	—	—	—	—	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

Bit 15 – Bit 8: Ignored

Bit 7 – Bit 0: Loop Run Information [Bit On(1): Run state, Bit Off(0): Stop state]

8.2.6 etting PID Control Data

1) The addresses for PID control data and their setting range are given as follows.

Address (10 decimal)		Item	Setting range	Default
K7F-PIDA	K4F-PIDA			
10~41	5~12	SV	0 ~ 16000	“0”
42~73	13~20	PV		
74~105	21~28	M_MV		
106~137	29~36	P constant (K*p*)	1 ~ 10000	“500”
138~169	37~44	I constant (K*i*)	0 ~ 30000	“1000”
170~201	45~52	D constant (K*d*)	0 ~ 30000	“0”

2) If PID control data is outside the range, the execution continues with the setting range of the previous processing.
3) If PID control data is outside its setting range, error information appear on the setting error information area.

4.2.7 Outputting Manipulated Value (K7F-PIDA : Addresses 202 to 233, K4F-PIDA : Addresses 53 to 60)

1) This area stores the MV of each loop.
2) The MV output range is 0 to 16000.

4.2.8 Setting Error Information (K7F-PIDA : Addresses 234 to 265, K4F-PIDA : Addresses 61 to 68)

1) When setting the control data for each loop, if any setting exceeds its range the error information is indicated on this area.
2) Bit 0 to 5 are used to indicate error information for each loop. The following shows the error information indicated by each bit when it turns On(1).

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	—	—	—	—	—	—	—	—	—	Kd info.	Ki info.	Kp info.	Manually MV info.	PV info.	SV info.

Bit 15 to Bit 6: Ignored

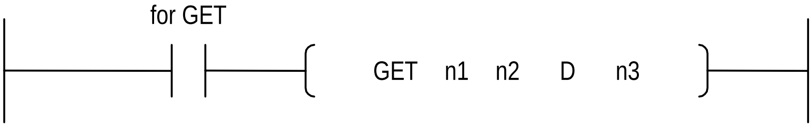
Bit 5 to Bit 0: Setting error information
[Bit On(1): Error, Bit Off(0): Normal

Chapter 5. DEDICATED INSTRUCTIONS FOR SPECIAL MODULES (Read from /Write to Buffer memory)

The PID module is available only for local and occupies 16 I/O points.

5.1 Read from Buffer Memory · · · GET, GETP

<Format>



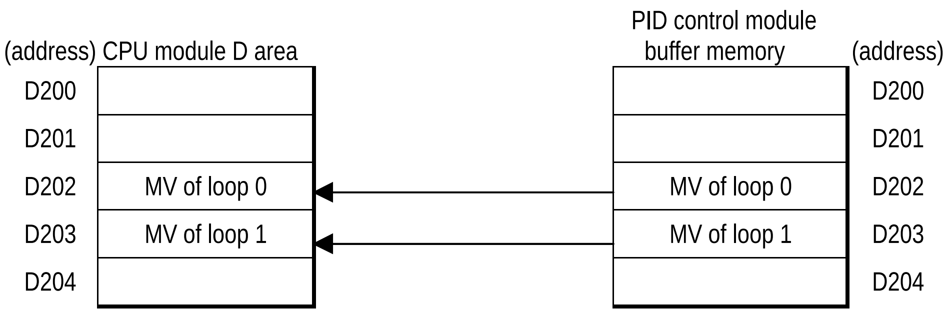
Format	Descriptions	Available Data Type
n1	The slot No. where a special module is mounted	Integer
n2	Head address of the special module buffer memories from which the data will be read.	Integer
D	Head address of the device to store the data read.	M,P,K,J,T,C,D,#D
n3	Number of data to be read .	Integer

<The difference between GET and GETP>

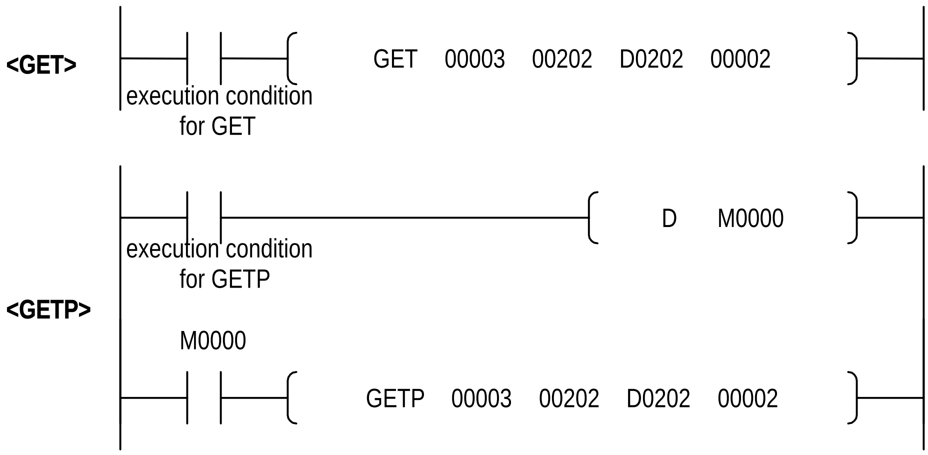
GET: Always executed if the execution condition turns on.( )

GETP : Executed if the execution condition is triggered. ( )

Example 1) In this example, the PID control module is mounted on the slot 3 in the base unit and the data of buffer memory addresses 202 and 203 will be read to the CPU module addresses D202 and D203.

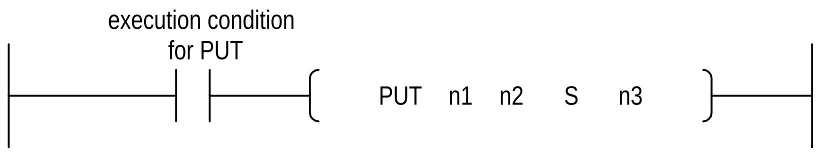


<GETP> execution condition for GETP



5.2 Write to Buffer Memory · · · PUT, PUTP

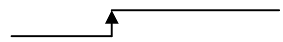
<Format>



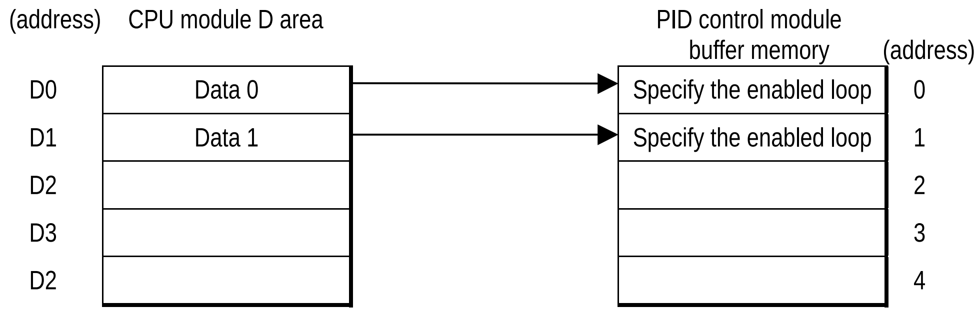
Format	Descriptions	Available Data Type
n1	The slot No. where a special module is mounted.	Integer
n2	Head address of the special module buffer memories to which the data will be written..	Integer
D	Head address of the device where the data to be written has been stored, or an integer	M,P,K,L,T,C,D,#D
n3	Number of data to be written.	Integer

<The difference between PUT and PUTP>

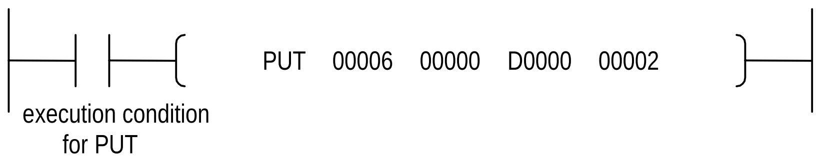
PUT: always executed if the execution condition turns on. **(**  **)**

PUTP : executed if the execution condition is triggered. **(**  **)**

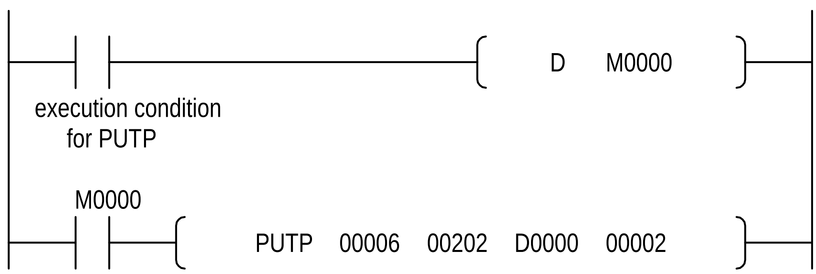
Example 1) In this example, the PID control module is mounted on the slot 6 in the base unit and the data of CPU module addresses D0 and D1 will be written to the buffer memory addresses D202 and D203.



<PUT>



<PUTP>

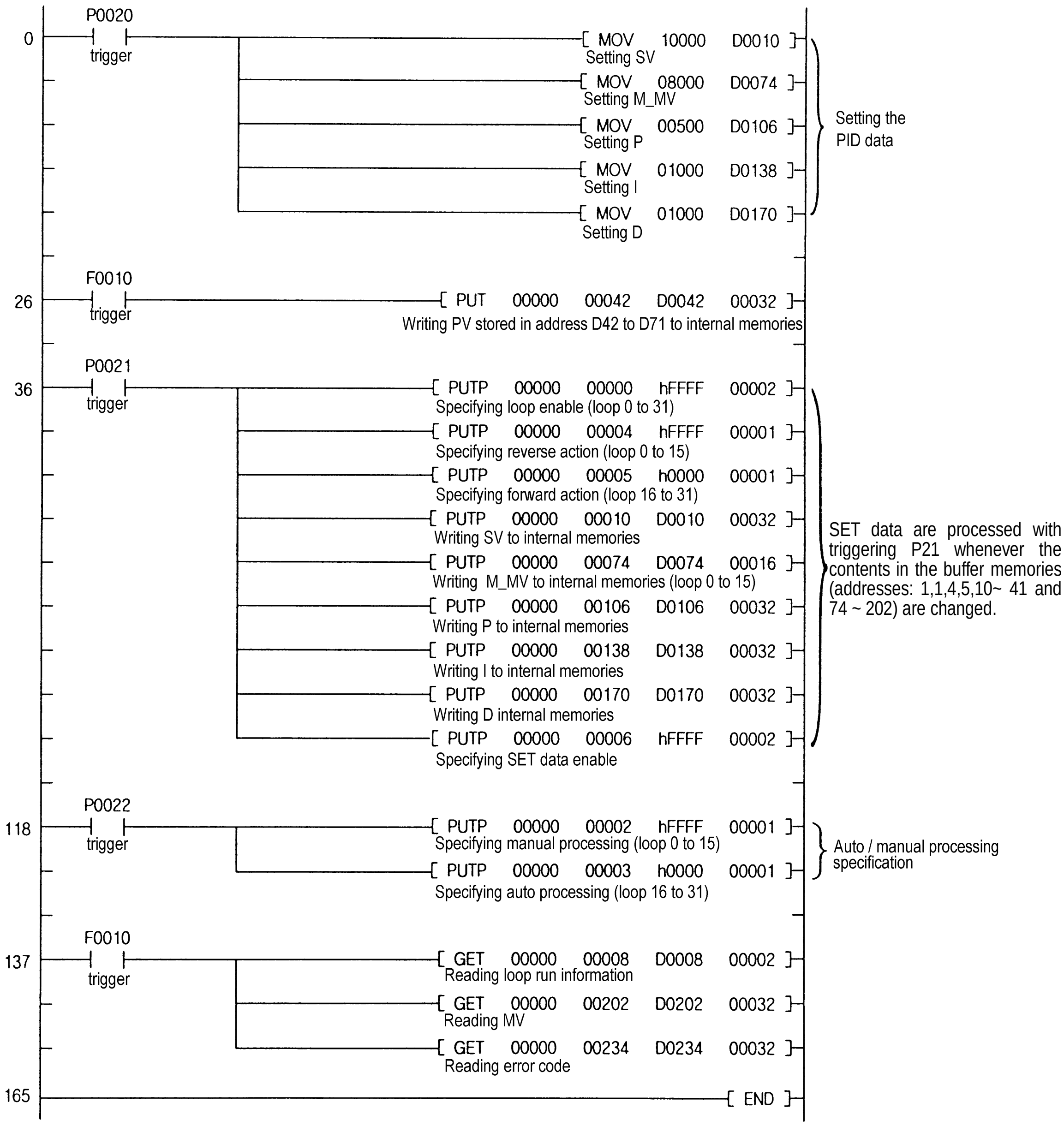


Chapter 6. PROGRAMMING

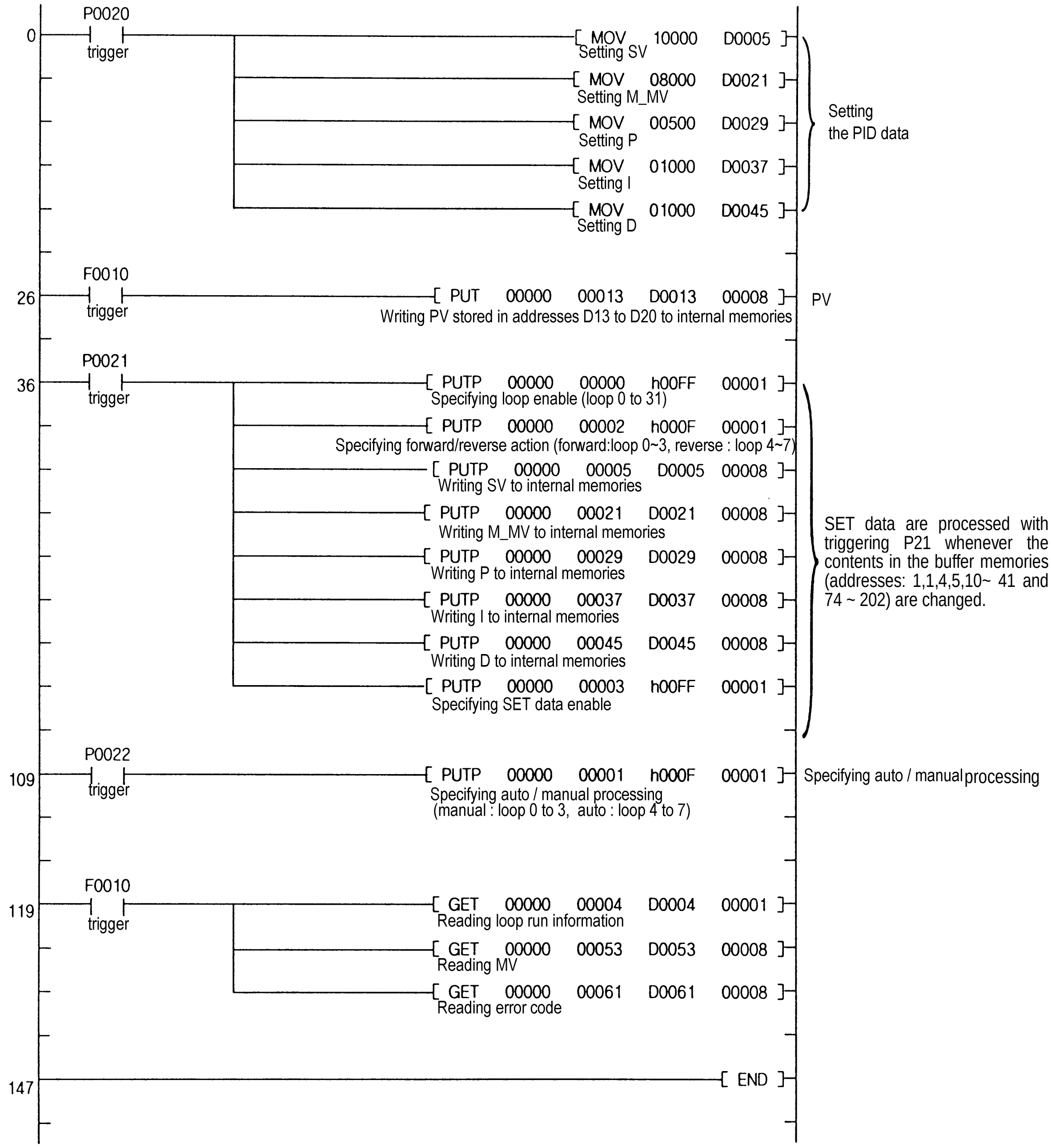
6.1 Basic Programming

▲ The following describes the method to set the running conditions in the buffer memories of the PID control module.
▲ The PID control module is already mounted on the slot 0.
▲ The PID control module occupies 16 I/O points.

6.1.1 K7F-PIDA



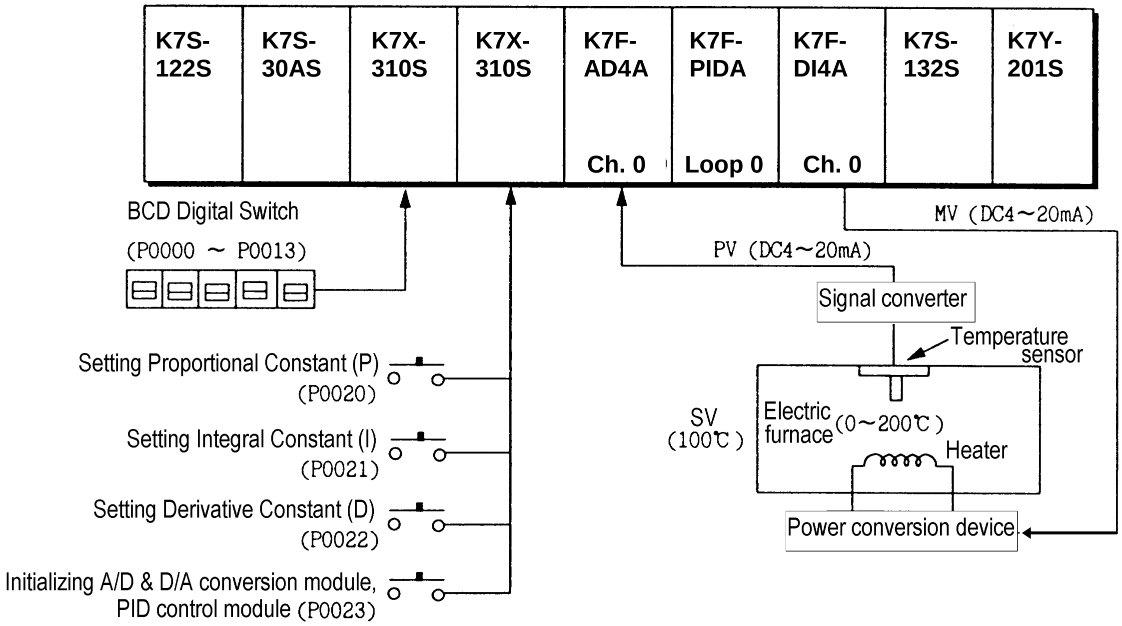
6.1.2 K4F-PIDA


0
P0020
trigger
MOV 10000 D0005
Setting SV
MOV 08000 D0021
Setting M_MV
MOV 00500 D0029
Setting P
MOV 01000 D0037
Setting I
MOV 01000 D0045
Setting D
Setting the PID data
26
F0010
trigger
PUT 00000 00013 D0013 00008
Writing PV stored in addresses D13 to D20 to internal memories
PV
36
P0021
trigger
PUTP 00000 00000 h00FF 00001
Specifying loop enable (loop 0 to 31)
PUTP 00000 00002 h000F 00001
Specifying forward/reverse action (forward:loop 0~3, reverse : loop 4~7)
PUTP 00000 00005 D0005 00008
Writing SV to internal memories
PUTP 00000 00021 D0021 00008
Writing M_MV to internal memories
PUTP 00000 00029 D0029 00008
Writing P to internal memories
PUTP 00000 00037 D0037 00008
Writing I to internal memories
PUTP 00000 00045 D0045 00008
Writing D to internal memories
PUTP 00000 00003 h00FF 00001
Specifying SET data enable
SET data are processed with triggering P21 whenever the contents in the buffer memories (addresses: 1,1,4,5,10~ 41 and 74 ~ 202) are changed.
109
P0022
trigger
PUTP 00000 00001 h000F 00001
Specifying auto / manual processing
(manual : loop 0 to 3, auto : loop 4 to 7)
Specifying auto / manual processing
119
F0010
trigger
GET 00000 00004 D0004 00001
Reading loop run information
GET 00000 00053 D0053 00008
Reading MV
GET 00000 00061 D0061 00008
Reading error code
147
END

6.2   Application Programming

6.2.1   A Program for Controlling an Electric Furnace (with Applying the A/D Conversion Module, PID Control Module and D/A Conversion Module)

1)   System Configuration



1)   Initial Settings

(1) PID control module
- A) Specifying used loop : loop 0
- B) Specifying forward/reverse action : forward action
- C) Setting SV: 12800
- D) Specifying auto/manual processing : auto processing

(2) A/D conversion module
- A) Specifying used channel: channel 0
- B) Specifying output data type: -192 to 16191
- C) Setting filter constant: 50

(3) D/A conversion module
- A) Specifying used channel: channel 0
- B) Specifying input data type: -192 to 16191
- C) Output when no channel is used or the CPU module is in the stop state : The median value of the output range is output.

2)   Descriptions of the Program

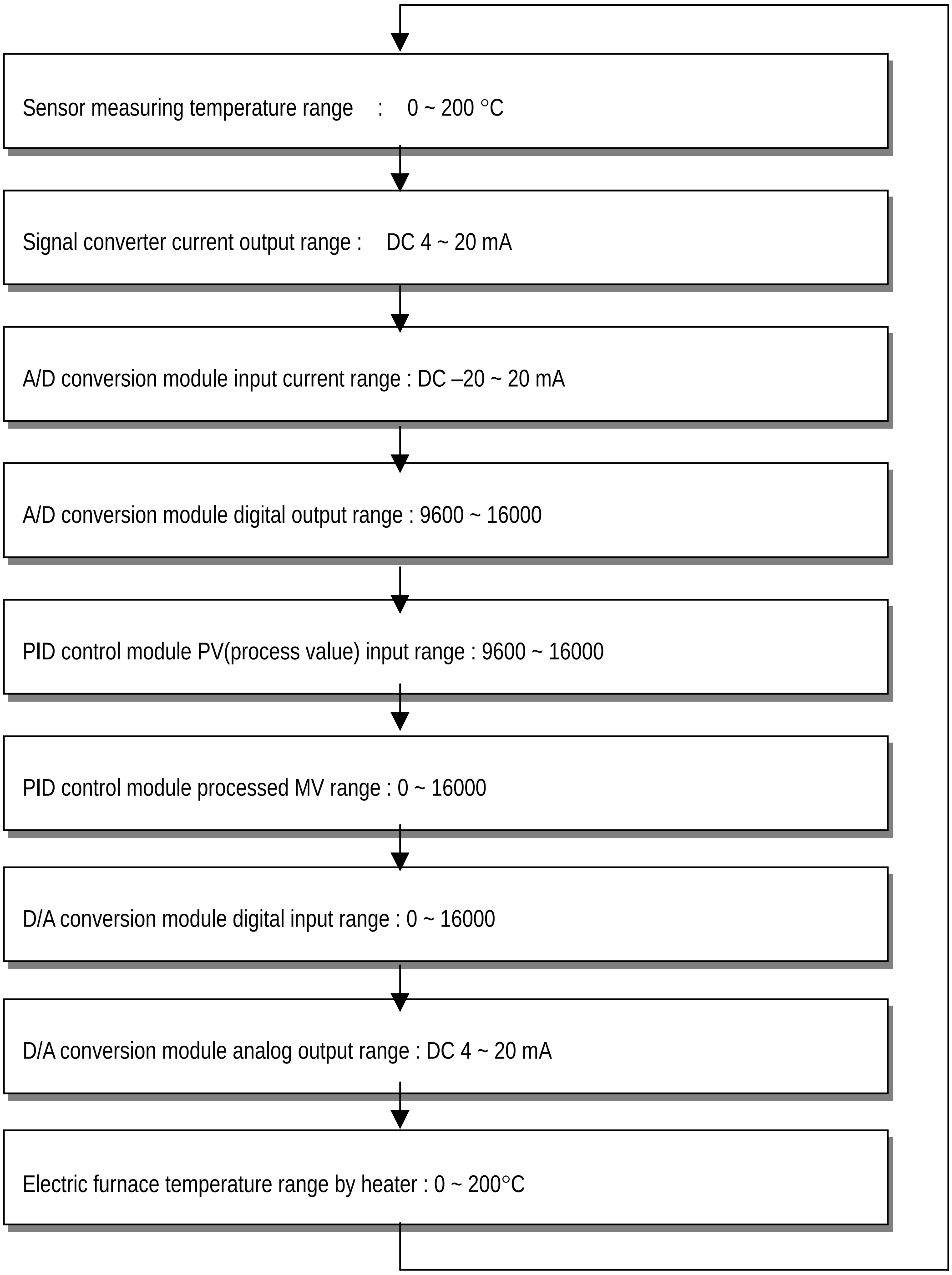
(1) A temperature 0 to 200°C from the temperature sensor is converted into an analog signal 4 to 20 mA and then the signal is input to the channel 0 of the A/D conversion module channel and converted into a digital value 9600 to 16000.

(2) In the PID control module, 100°C (where the signal converter output is 12 mA, 12800 as a digital value.) is set as SV. With regards to P.I.D constants, the manipulated value in the BCD digital switch is set as the proportional constant when P0020 turns on, as the integral constant when POO21 turns on, and as the Derivative constant when P0022 turns on.

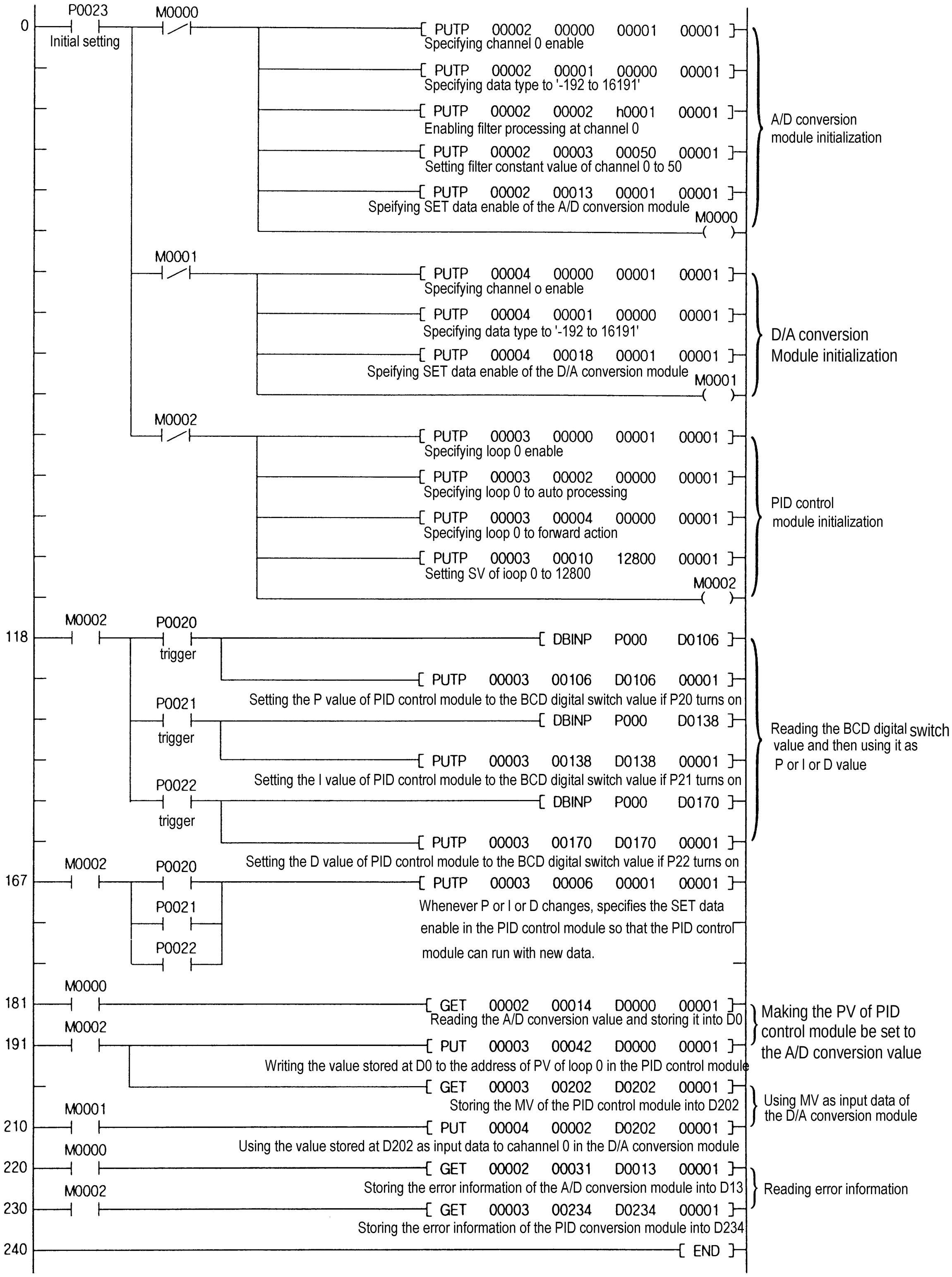
(3) MV, the result from PID processing is output at the channel 0 of the D/A conversion module.

(4) If P0023 turns on, initial setting of the A/D conversion module, PID control module and D/A conversion module is executed.

3) Modules and their Signal Processing

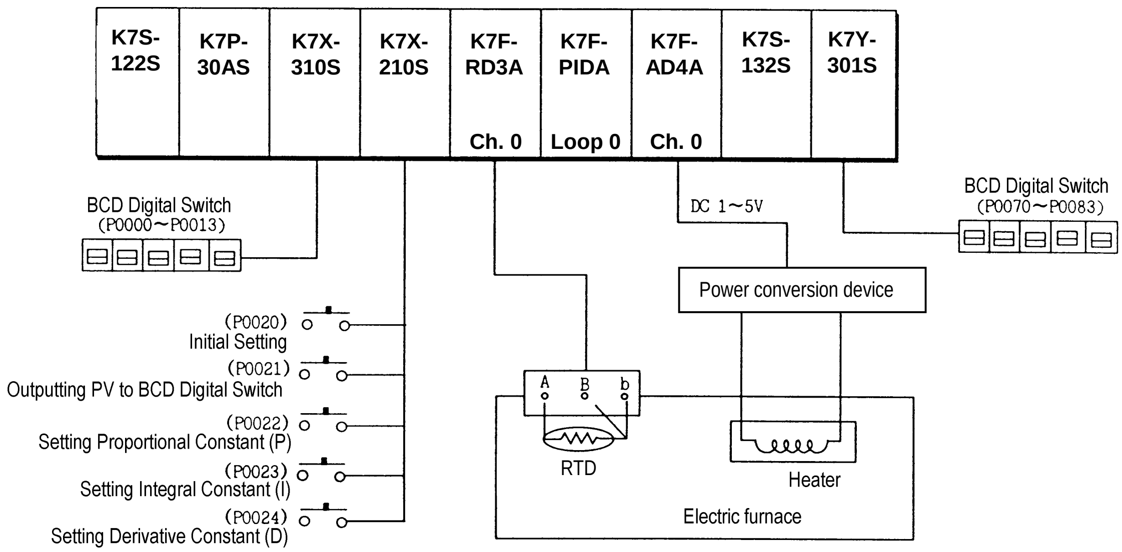


5) Program


0
P0023
Initial setting
M0000
[PUTP 00002 00000 00001 00001]
Specifying channel 0 enable
[PUTP 00002 00001 00000 00001]
Specifying data type to '-192 to 16191'
[PUTP 00002 00002 h0001 00001]
Enabling filter processing at channel 0
[PUTP 00002 00003 00050 00001]
Setting filter constant value of channel 0 to 50
[PUTP 00002 00013 00001 00001]
Speifying SET data enable of the A/D conversion module
M0000
A/D conversion module initialization
M0001
[PUTP 00004 00000 00001 00001]
Specifying channel o enable
[PUTP 00004 00001 00000 00001]
Specifying data type to '-192 to 16191'
[PUTP 00004 00018 00001 00001]
Speifying SET data enable of the D/A conversion module
M0001
D/A conversion Module initialization
M0002
[PUTP 00003 00000 00001 00001]
Specifying loop 0 enable
[PUTP 00003 00002 00000 00001]
Specifying loop 0 to auto processing
[PUTP 00003 00004 00000 00001]
Specifying loop 0 to forward action
[PUTP 00003 00010 12800 00001]
Setting SV of ioop 0 to 12800
M0002
PID control module initialization
118
M0002
P0020
trigger
[DBINP P000 D0106]
[PUTP 00003 00106 D0106 00001]
Setting the P value of PID control module to the BCD digital switch value if P20 turns on
P0021
trigger
[DBINP P000 D0138]
[PUTP 00003 00138 D0138 00001]
Setting the I value of PID control module to the BCD digital switch value if P21 turns on
P0022
trigger
[DBINP P000 D0170]
[PUTP 00003 00170 D0170 00001]
Setting the D value of PID control module to the BCD digital switch value if P22 turns on
Reading the BCD digital switch value and then using it as P or I or D value
167
M0002
P0020
P0021
P0022
[PUTP 00003 00006 00001 00001]
Whenever P or I or D changes, specifies the SET data enable in the PID control module so that the PID control module can run with new data.
181
M0000
[GET 00002 00014 D0000 00001]
Reading the A/D conversion value and storing it into D0
191
M0002
[PUT 00003 00042 D0000 00001]
Writing the value stored at D0 to the address of PV of loop 0 in the PID control module
Making the PV of PID control module be set to the A/D conversion value
[GET 00003 00202 D0202 00001]
Storing the MV of the PID control module into D202
210
M0001
[PUT 00004 00002 D0202 00001]
Using the value stored at D202 as input data to cahannel 0 in the D/A conversion module
Using MV as input data of the D/A conversion module
220
M0000
[GET 00002 00031 D0013 00001]
Storing the error information of the A/D conversion module into D13
230
M0002
[GET 00003 00234 D0234 00001]
Storing the error information of the PID conversion module into D234
Reading error information
240
[END]

10.2.2 A Program for Control Using a RTD (with Applying the RTD Input Module, PID Control Module and D/A Conversion Module)

1) System Configuration



2) Initial Settings

(1) PID control module
- A) Specifying used loop : loop 0
- B) Specifying forward/reverse action: forward action
- C) Specifying the Set Value: 8000
- D) Specifying auto/manual processing : auto processing

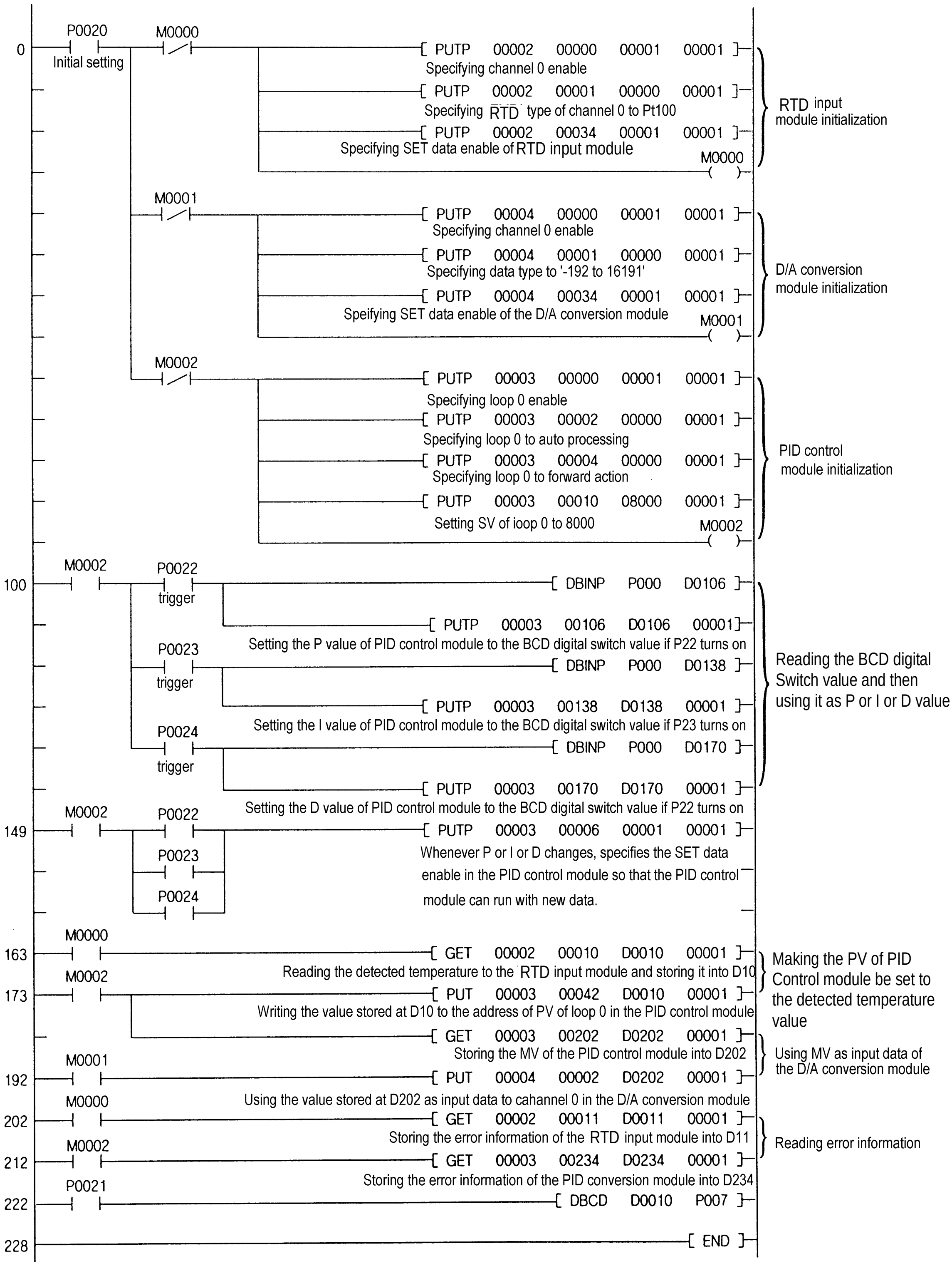
(2) RTD input module
- A) Specifying used channel: channel 0
- B) Specifying RTD sensor type: Pt100

(3) D/A conversion module
- A) Setting the voltage input range to –5 to 5 DCV (offset: DC 1V, gain: DC 3V)
- B) Specifying used channel : channel 0
- C) Specifying input data type : 0 to 16000

3) Descriptions of the Program

(1) The channel 0 of the RTD input module detects a temperature of the electric furnace through Pt100 and receives it as a digital value.
(2) The Set Value of PID control module loop 0 is set to 8000(where the temperature is 100°C). With regards to P.I.D constants, the manipulated value in the BCD digital switch is set to the proportional constant when P0022 turns on, to the integral constant when P0023 turns on, and to the Derivative constant when P0023 turns on. As the change of MV, the manipulated value in the BCD digital switch is set to a new MV.
(3) MV, the result from PID processing is output at the channel 0 of the D/A conversion module.
(4) If P0021 turns on, PV is displayed on the BCD digital LED.

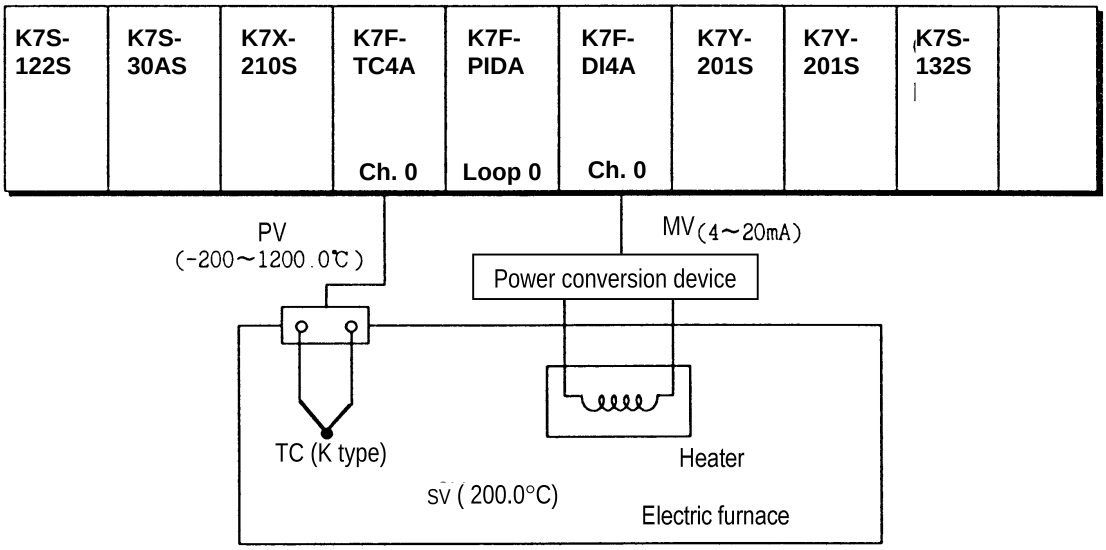
4) Program



0
P0020
Initial setting
M0000
[PUTP 00002 00000 00001 00001]
Specifying channel 0 enable
[PUTP 00002 00001 00000 00001]
Specifying RTD type of channel 0 to Pt100
[PUTP 00002 00034 00001 00001]
Specifying SET data enable of RTD input module
M0000
RTD input module initialization
M0001
[PUTP 00004 00000 00001 00001]
Specifying channel 0 enable
[PUTP 00004 00001 00000 00001]
Specifying data type to '-192 to 16191'
[PUTP 00004 00034 00001 00001]
Speifying SET data enable of the D/A conversion module
M0001
D/A conversion module initialization
M0002
[PUTP 00003 00000 00001 00001]
Specifying loop 0 enable
[PUTP 00003 00002 00000 00001]
Specifying loop 0 to auto processing
[PUTP 00003 00004 00000 00001]
Specifying loop 0 to forward action
[PUTP 00003 00010 08000 00001]
Setting SV of ioop 0 to 8000
M0002
PID control module initialization
100
M0002
P0022
trigger
[DBINP P000 D0106]
[PUTP 00003 00106 D0106 00001]
Setting the P value of PID control module to the BCD digital switch value if P22 turns on
P0023
trigger
[DBINP P000 D0138]
[PUTP 00003 00138 D0138 00001]
Setting the I value of PID control module to the BCD digital switch value if P23 turns on
P0024
trigger
[DBINP P000 D0170]
[PUTP 00003 00170 D0170 00001]
Setting the D value of PID control module to the BCD digital switch value if P22 turns on
Reading the BCD digital Switch value and then using it as P or I or D value
149
M0002
P0022
P0023
P0024
[PUTP 00003 00006 00001 00001]
Whenever P or I or D changes, specifies the SET data enable in the PID control module so that the PID control module can run with new data.
163
M0000
[GET 00002 00010 D0010 00001]
Reading the detected temperature to the RTD input module and storing it into D10
173
M0002
[PUT 00003 00042 D0010 00001]
Writing the value stored at D10 to the address of PV of loop 0 in the PID control module
Making the PV of PID Control module be set to the detected temperature value
[GET 00003 00202 D0202 00001]
Storing the MV of the PID control module into D202
192
M0001
[PUT 00004 00002 D0202 00001]
Using the value stored at D202 as input data to cahannel 0 in the D/A conversion module
Using MV as input data of the D/A conversion module
202
M0000
[GET 00002 00011 D0011 00001]
Storing the error information of the RTD input module into D11
212
M0002
[GET 00003 00234 D0234 00001]
Storing the error information of the PID conversion module into D234
Reading error information
222
P0021
[DBCD D0010 P007]
228
[END]

6.2.3 A Program for Control Using a Thermocouple
(with Applying the TC Input Module, PID Control Module and D/A Conversion Module)

1) System Configuration



2) Initial Settings

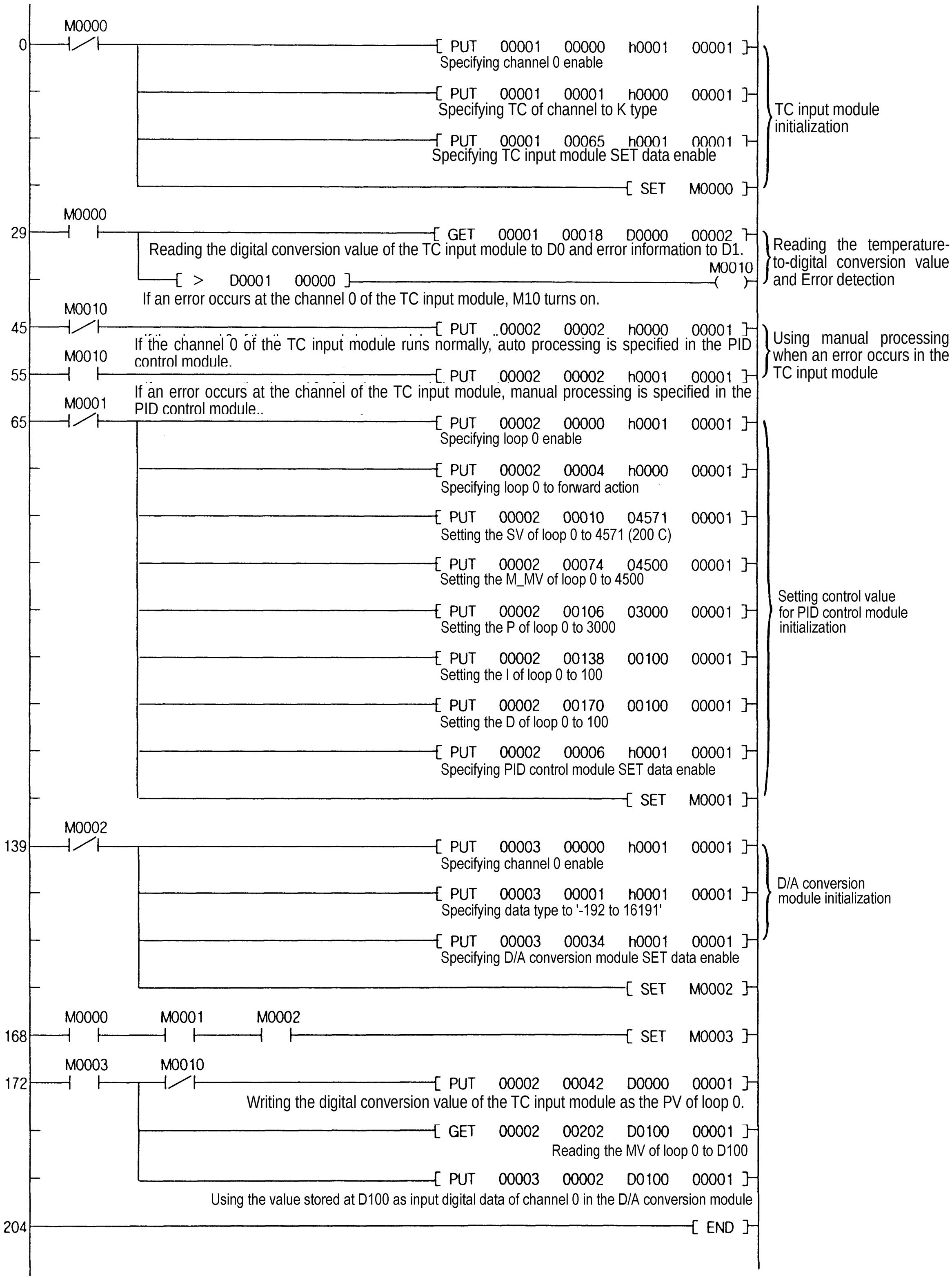
(1) TC input module
   A) Specifying used channel : channel 0
   B) Specifying TC type: K type

(2) PID control module
   A) Specifying used loop : loop 0
   B) Specifying forward/reverse action: forward action
   C) Specifying auto/manual processing : auto processing
   D) Setting SV: 200°C (4571 as digital value)
   E) Setting M_MV (Used when errors occur) : 4500
   F) Setting P : 3000
   G) Setting I : 100
   H) Setting D : 100
   I) Auto processing is changed to manual processing when errors occur.

(3) D/A conversion module
   A) Specifying used channel: channel 0
   B) Specifying input data type: -192 ~ 16191
   C) The output when no channel is used or the CPU module is in the stop state : The median value of the output range.

3) Descriptions of the Program
1) The temperature of the electric furnace is converted into a digital value through the channel 0 of the TC input module, and the digital value stored at address 18 is used as PV of the PID control module.
2) The MV of the PID control module is used as input digital data of the channel 0 of the D/A conversion module.
3) If an error occurs by the K type TC or the compensation wire which are connected to the TC input module (In the channel 0, it is indicated at address 19.), then the PID control module changes auto processing into manual processing.

4) Program


0
M0000
PUT 00001 00000 h0001 00001
Specifying channel 0 enable
PUT 00001 00001 h0000 00001
Specifying TC of channel to K type
PUT 00001 00065 h0001 00001
Specifying TC input module SET data enable
SET M0000
TC input module initialization
29
M0000
GET 00001 00018 D0000 00002
Reading the digital conversion value of the TC input module to D0 and error information to D1.
> D0001 00000
M0010
If an error occurs at the channel 0 of the TC input module, M10 turns on.
Reading the temperature-to-digital conversion value and Error detection
45
M0010
PUT 00002 00002 h0000 00001
If the channel 0 of the TC input module runs normally, auto processing is specified in the PID control module.
55
M0010
PUT 00002 00002 h0001 00001
If an error occurs at the channel of the TC input module, manual processing is specified in the PID control module..
Using manual processing when an error occurs in the TC input module
65
M0001
PUT 00002 00000 h0001 00001
Specifying loop 0 enable
PUT 00002 00004 h0000 00001
Specifying loop 0 to forward action
PUT 00002 00010 04571 00001
Setting the SV of loop 0 to 4571 (200 C)
PUT 00002 00074 04500 00001
Setting the M_MV of loop 0 to 4500
PUT 00002 00106 03000 00001
Setting the P of loop 0 to 3000
PUT 00002 00138 00100 00001
Setting the I of loop 0 to 100
PUT 00002 00170 00100 00001
Setting the D of loop 0 to 100
PUT 00002 00006 h0001 00001
Specifying PID control module SET data enable
SET M0001
Setting control value for PID control module initialization
139
M0002
PUT 00003 00000 h0001 00001
Specifying channel 0 enable
PUT 00003 00001 h0001 00001
Specifying data type to '-192 to 16191'
PUT 00003 00034 h0001 00001
Specifying D/A conversion module SET data enable
SET M0002
D/A conversion module initialization
168
M0000
M0001
M0002
SET M0003
172
M0003
M0010
PUT 00002 00042 D0000 00001
Writing the digital conversion value of the TC input module as the PV of loop 0.
GET 00002 00202 D0100 00001
Reading the MV of loop 0 to D100
PUT 00003 00002 D0100 00001
Using the value stored at D100 as input digital data of channel 0 in the D/A conversion module
204
END

Chapter 7. TROUBLESHOOTING

The followings explain errors that could occur during operating the PID control module and their troubleshooting.

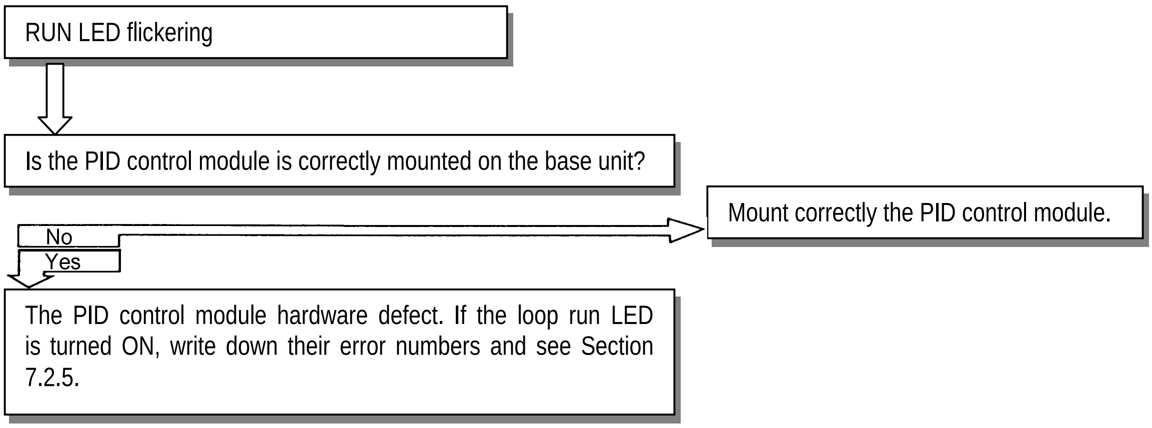
7.1 Errors Indicated by RUN LED Flickering

Errors indicated by PID control module RUN LED flickering are given below.

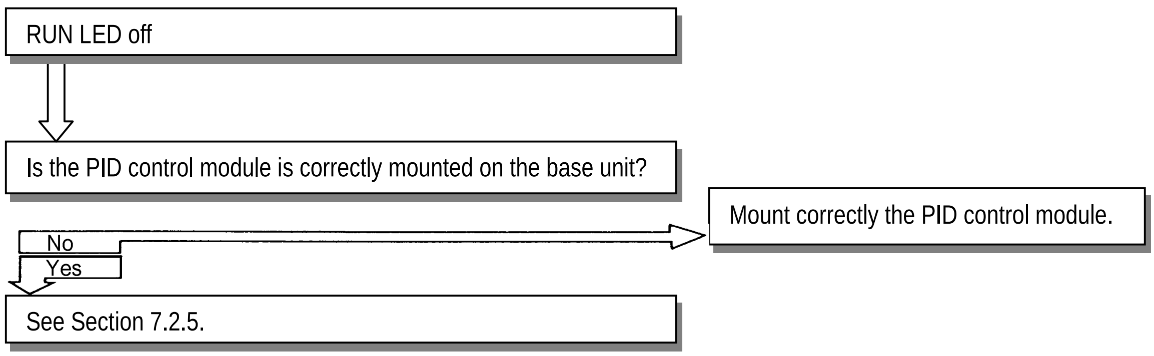
RUN LED Status	Error Type	Loop RUN LED status
Flickering (cycle: 0.1 sec)	WDT Error	Loop “0” RUN LED ON
Flickering (cycle: 0.2 sec)	System Error	All Loops RUN LED OFF
	Buffer Memory Error	Loop “1” RUN LED ON

7.2 Troubleshooting Procedure

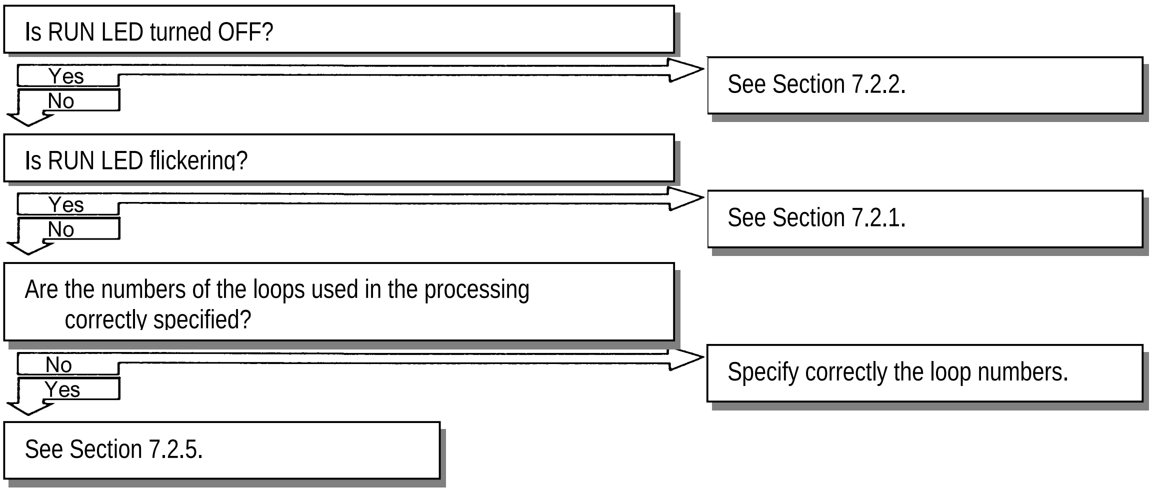
7.2.1 RUN LED Flickering



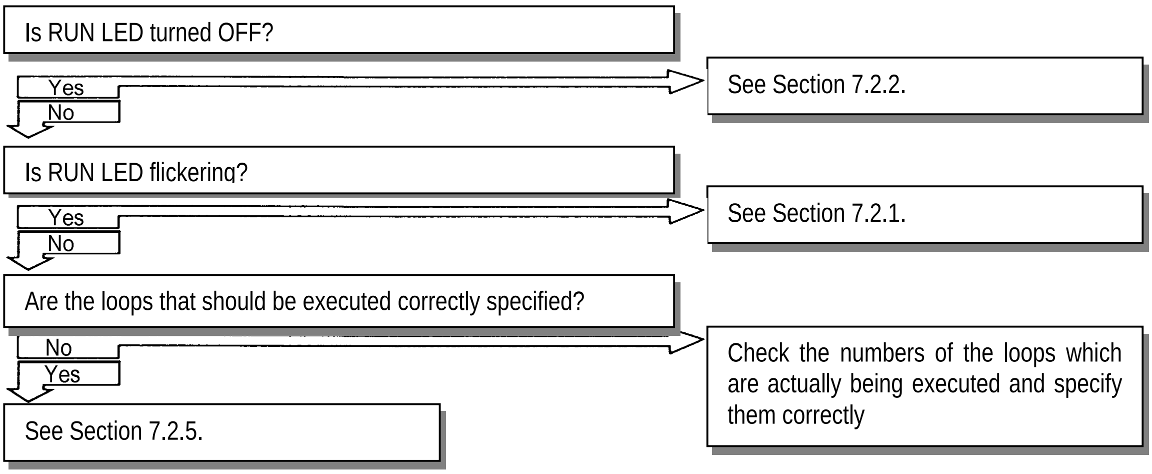
7.2.2 RUN LED Off



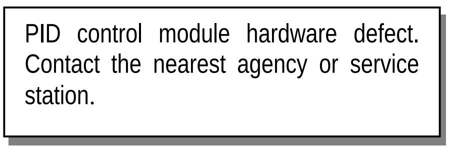
4.2.3 Unreadable Processing Result of PID control module



4.2.4 Run LED of enabled Loops Off

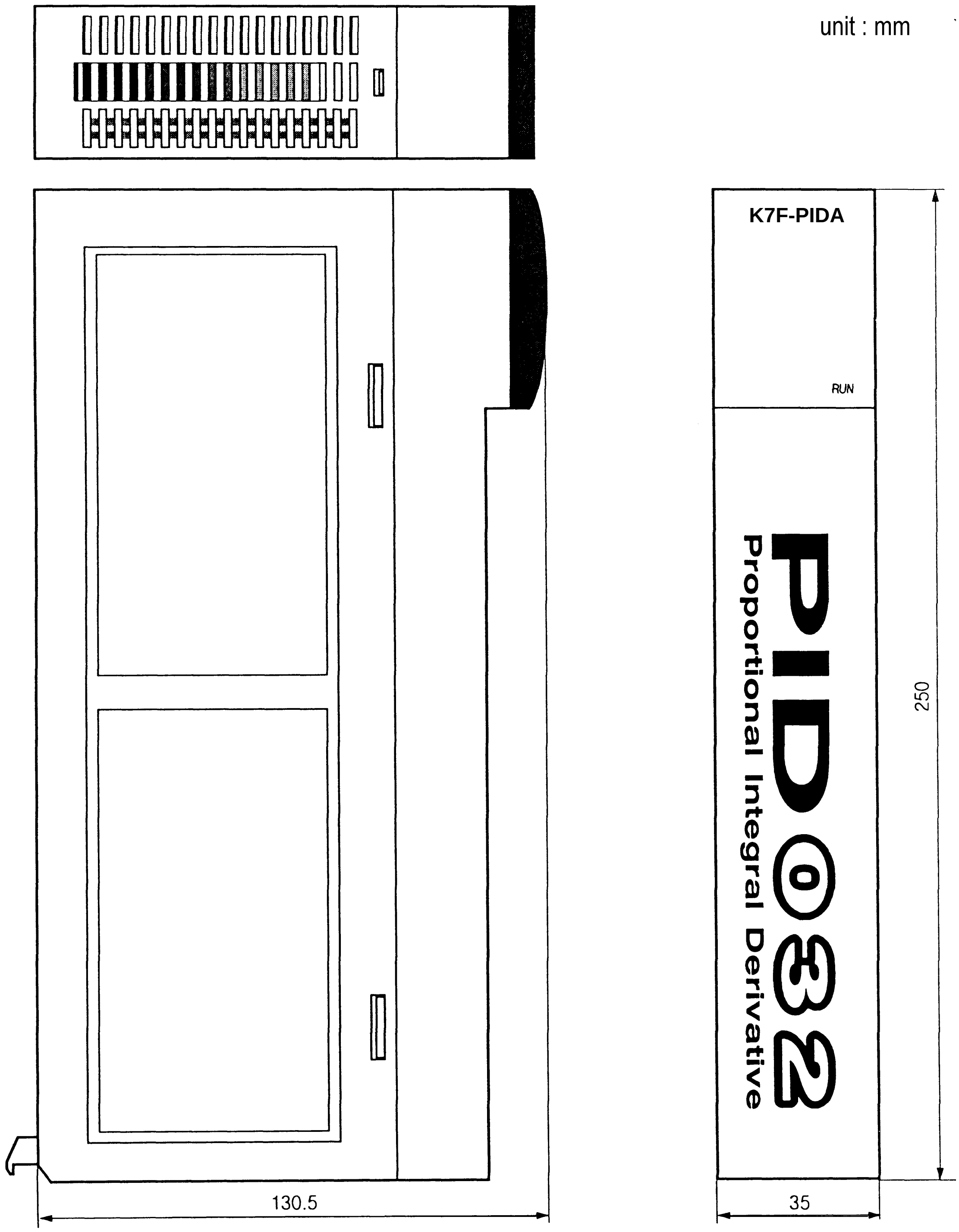


4.2.5 PID Control Module Hardware Defect



Chapter 8. DIMENSIONS

8.1 K7F-PIDA Dimensions.



8.2 K4F-PIDA Dimensions

unit : mm